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Per BI
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HARVARD UNIVERSITY
ARNOLD ARBORETUM
PRESENTED BY CHARLES SPRAGUE SARGENT
1892

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JOURNAL

OF THE

ROYAL HORTICULTURAL SOCIETY

EDITED BY THE

REV. W. WILKS, M.A.

SECRETARY

VOL. XXIV.

Hybrid Conference Report

1900

LONDON
Printed for the Royal Horticultural Society
BY
SPOTTISWOODE & CO., NEW-STREET SQUARE, E.C.

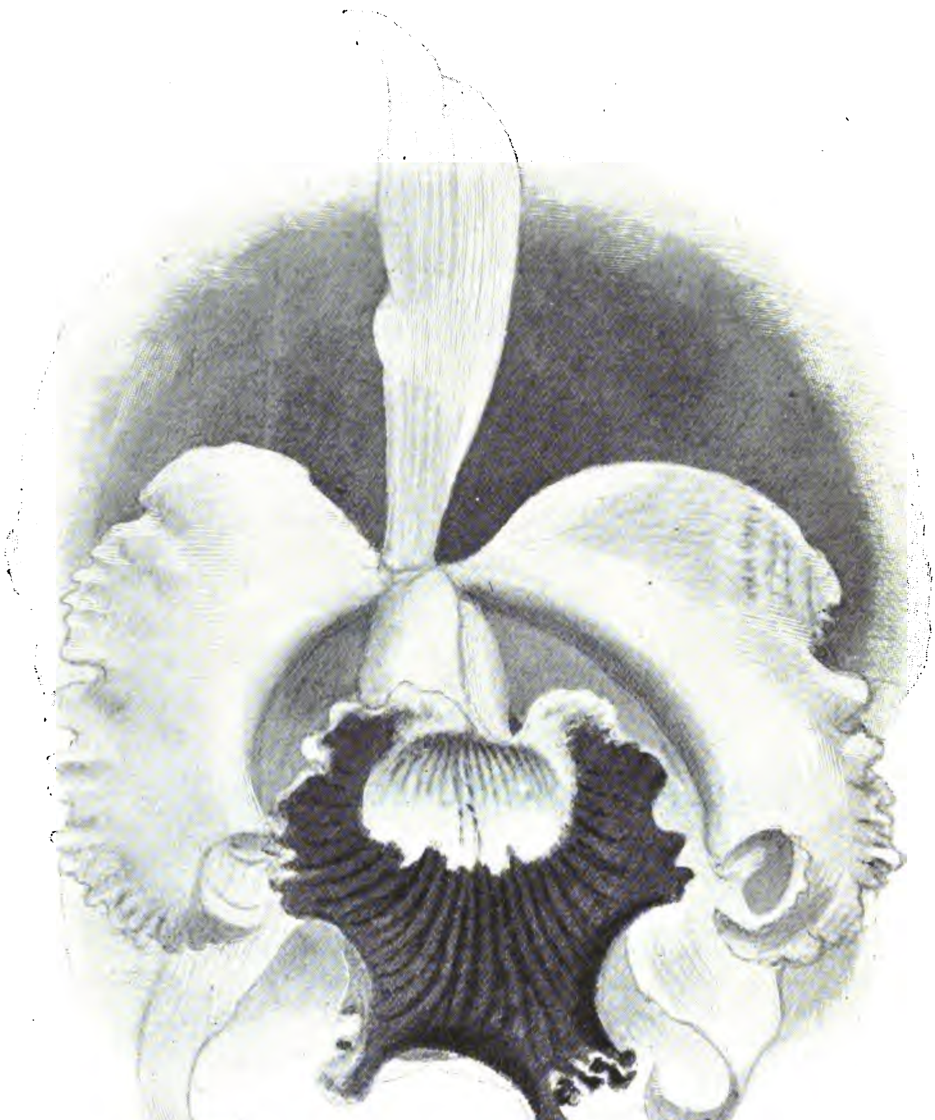

FIG. 124.—LÆLIO-CATTLEYA APHRODITE RUTH. (*Journal of Horticulture.*
(CATTLEYA MENDELI × LÆLIA PURPURATA.)

CONTENTS OF VOL. XXIV.

HYBRID CONFERENCE REPORT.

JOURNAL

OF THE

ROYAL HORTICULTURAL SOCIETY.

VOL. XXIV. 1900.

HYBRID CONFERENCE REPORT.

THE Council of the Society having decided in the Autumn of 1898 to hold a Conference on Hybridisation in July 1899, the following Schedule was drawn up and issued in January 1899. It is reprinted here in full, as being of some historical interest, and also because it may prove suggestive for any future similar meetings :—

Royal Horticultural Society.

Established A.D. 1804. Incorporated A.D. 1809.

INTERNATIONAL CONFERENCE.

1899.

Tuesday, July 11th, at Chiswick,

Wednesday, July 12th, in London.

On Hybridisation (the Cross-Breeding of Species) and on the Cross-Breeding of Varieties.

COMMITTEE OF ARRANGEMENT.

F. W. BURBIDGE, M.A., V.M.H.
SIR WILLIAM THISELTON-DYER, K.C.M.G., F.R.S.
JAMES DOUGLAS, V.M.H.
REV. G. H. ENGLEHEART, M.A.
REV. PROFESSOR G. HENSLOW, M.A., V.M.H.
JAMES HUDSON, V.M.H.
F. G. LLOYD, F.R.H.S.
MAXWELL T. MASTERS, M.D., F.R.S.
T. J. BENNETT-POË, F.R.H.S.
CHARLES E. SHEA, F.R.H.S.
HARRY J. VEITCH, F.L.S.
REV. WILLIAM WILKS, M.A., Sec. R.H.S.

NOTE.

All plant-growers, whether amateurs or nurserymen, are particularly requested to exhibit Hybrid or Cross-bred Plants (whether in bloom or not), with their parents, at the meeting of the Conference at Chiswick on Tuesday, July 11. All plants should arrive at the Society's Gardens at Chiswick at or before 11.30 A.M., and may be removed at 5 P.M.

The ordinary Committees of the Society will meet at Chiswick on Tuesday, July 11, at 12 punctually, and plants, &c., *for Certificate* will be placed before them as at the usual meetings in the Drill Hall, but with the exception of plants, &c., for certificate, and hybrids and their parents, no other plants, &c., may be exhibited on this day.

TUESDAY, JULY 11TH (CHISWICK).

CLASS

1. New and Rare Plants and Flowers. *Open* . . *Certificates.*
2. New and Rare Fruits and Vegetables. *Open* . . *Certificates.*

Any New or Rare Plants, &c., may be shown for Certificate exactly in the same way as at the Drill Hall.

N.B.—The Exhibition of Hybrid and Cross-bred Plants, whether in blossom or not, is specially requested, with their parents if possible, and a written account of the origin of the Hybrid; but with the exception of Plants, &c., shown for Certificate, none but such specially indicated plants may be shown. No Groups or Miscellaneous Exhibits. Other Awards will be given to Exhibits of Hybrids, but the following are specifically offered :—

3. A Veitch Memorial Medal to the raiser of the best new FRUIT intentionally raised by cross-breeding or hybridisation in Great Britain, and never previously exhibited.
4. A Veitch Memorial Medal to the raiser of the best new FLOWER (Orchids excluded) intentionally raised by cross-breeding or hybridisation in Great Britain, and never previously exhibited.
5. A Veitch Memorial Medal to the raiser of the best new ORCHID intentionally raised by cross-breeding or hybridisation in Great Britain, and never previously exhibited.
6. A Veitch Memorial Medal to the raiser of the best new VEGETABLE intentionally raised by cross-breeding or hybridisation in Great Britain, and never previously exhibited.
7. A Veitch Memorial Medal to the raiser of the best new FRUIT intentionally raised by cross-breeding or hybridisation out of Great Britain, and never previously exhibited.
8. A Veitch Memorial Medal to the raiser of the best new FLOWER (Orchids excluded) intentionally raised by cross-breeding or hybridisation out of Great Britain, and never previously exhibited.
9. A Veitch Memorial Medal to the raiser of the best new ORCHID intentionally raised by cross-breeding or hybridisation out of Great Britain, and never previously exhibited.
10. A Veitch Memorial Medal to the raiser of the best new VEGETABLE intentionally raised by cross-breeding or hybridisation out of Great Britain, and never previously exhibited.

The above Medals will only be awarded should the exhibits be considered sufficiently meritorious, and the result of intentional, not accidental, cross-fertilisation.

Exhibitors must give FULL details in writing as to parentage, and record any other points which may assist the Judges.

11. A Williams Memorial Medal to the best collection of Hybrid and Cross-bred PLANTS.

MEETINGS.

12 NOON. Fruit, Floral, and Orchid Committees meet.

12.45. The President of the Society, Sir Trevor Lawrence, Bart., V.M.H., will receive the invited Members of the Conference.

1 P.M. Luncheon.

2.15 P.M. Conference on Hybridisation and Cross-breeding.

5.0 P.M. Conference adjourns.

6.0 for 6.30 P.M. The Foreign Members of the Conference will be entertained at dinner on the kind invitation of the Horticultural Club, under the presidency of Sir John D. T. Llewelyn, Bart., M.P., at the Hotel Windsor, Victoria Street. Morning Dress.

WEDNESDAY, JULY 12TH (WESTMINSTER TOWN HALL).

MEETINGS.

2.0 P.M. Conference continued at Westminster Town Hall.

5.0 P.M. Conference concludes.

6.30 P.M. Reception of Guests by the President of the Society and Lady Lawrence at the Whitehall Rooms, Hôtel Métropole.

7.0 P.M. Banquet of the Society. Evening Dress. All Fellows can, as far as space will permit, obtain tickets (price 21*s.* each) for ladies or gentlemen, by applying (with cheque or postal order) to the Secretary, 117 Victoria Street, before July 5th.

The following arrangements are subject to alteration:—

TUESDAY, JULY 11TH, AT CHISWICK, AT 2.15 P.M.

1. Introductory observations.
   Maxwell Masters, M.D., F.R.S., London, Chairman.
2. Hybridisation and Cross-breeding as a Method of Scientific Investigation.
   W. Bateson, Esq., M.A., F.R.S., Cambridge University.
3. Hybridisation as a means of Pangenetic Infection.
   Professor Hugo de Vries, Amsterdam University.
4. Hybridisation and its Failures.
   The Rev. Professor Geo. Henslow, M.A., V.M.H., London.
5. Progress of Hybridisation in the United States of America.
   Professor L. H. Bailey, Cornell University, Ithaca, U.S.A.
6. Experiments in Hybridisation and Cross-breeding.
   C. C. Hurst, Esq., F.R.H.S., F.L.S., Burbage, Hinckley.

WEDNESDAY, JULY 12TH, AT THE TOWN HALL, WESTMINSTER, AT 2.15 P.M.

1. Introductory observations.
   Sir Michael Foster, K.C.B., Sec. R.S., *Chairman.*
2. Work of the United States Department of Agriculture in Plant Hybridisation; with Lantern Demonstration.
   Herbert J. Webber, Esq., Washington, U.S.A.; Special Envoy from the United States Department of Agriculture.
3. The structure of certain New Hybrids (Passiflora, Albuca, Ribes, Begonia, &c.); with Lantern Demonstration.
   Dr. J. H. Wilson, F.R.S.E., St. Andrews University, Scotland.
4. Hybridisation viewed from the standpoint of Systematic Botany.
   R. Allen Rolfe, Esq., The Royal Gardens, Kew.
5. Hybrid Poppies.
   Monsieur Henry de Vilmorin, F.R.H.S., Verrières, France.
6. Self-fertilisation of Plants.
   Monsieur Lemoine, F.R.H.S., Nancy, France.
7. Hybrid and Cross-bred Fruits.
   Luther Burbank, Esq., San Rosa, California, U.S.A.
   T. Francis Rivers, Esq., V.M.H., Sawbridgeworth.
8. Hybrid or Cross-bred Irises, Begonias, Chrysanthemums, Cinerarias, Rhododendrons, Clematis, Fuchsias, Violas, Gladiolus, &c.
   Sir Michael Foster, K.C.B., Sec. R.S., Monsieur Crozy, Messrs. J. Laing, V.M.H., Chas. E. Shea, W. J. James, F. G. Waterer, Harry J. Veitch, A. G. Jackman, J. Lye, G. Yeld, J. Heal, V.M.H., Monsieur V. Lemoine, and Dr. Stuart have been invited to supply short papers on these subjects.

Papers have already been promised by Monsieur Duval on Gesneriaceæ, Anthurium, and Bromeliaceæ; by Dr. Stuart, on Violas, &c.; by Mr. A. G. Jackman, on Clematis; by Mr. Charles T. Druery, V.M.H., on Ferns; by Monsieur Truffaut, on Bromelias; by Monsieur de la Devansaye, on Anthuriums; by Mr. James Lye, on Fuchsias; by Mr. William Smythe, on Cross-breeding; by Professor Ludwig, on Self-fertilisation; by Mr. T. Meehan, on Hybrids; by Heer Krelage; and by Mr. George Paul, V.M.H.

The writers of Papers are requested to give all the information possible; and those who are able to be present in person are requested to give an epitome of their arguments, or to mark off portions of their Papers which can be read within a limit of from 20 to 30 minutes.

The final selection of the Papers to be read at the Meetings and their order must be determined at the time, and will be left to the discretion of the Chairman and Committee; but *all the Papers* will be printed in full in the Society's official report of the Conference.

All MSS. in a foreign language should be sent to the Secretary at least 10 days before the Conference that they may be translated in readiness.

Amateurs, Nurserymen, and Gardeners are requested to send exhibits of True Hybrids, and of any plants known to be of cross-bred origin; also of Graft Hybrids; for exhibition at Chiswick on 11th.

In order that accurate results may be arrived at, and to facilitate comparisons and deductions, a card (as shown) will be supplied to all exhibitors on application, which it is requested may be carefully filled up with all the necessary details. When either the seed or pollen Parents, or both, are themselves cross-bred, it is particularly requested that the pedigree may be given through as many generations of ancestors as possible. Exhibitors are most earnestly requested to apply for their cards beforehand, and to fill them up accurately and legibly. Each separate plant should be entered on a separate card so as to avoid confusion—only one plant on one card.

Anyone who will be so kind as to send plants or cuttings of Hybrids to be grown at Chiswick in readiness for the Conference will receive the best thanks of the Council.

SPECIMEN OF CARD (Reduced).

HYBRID OR CROSS-BRED PLANT.

Raised by Mr. .... *Address*..................................

Exhibited by Mr........................ *Address*.................................

Date of Cross ....

Name of Hybrid or Cross-bred.	Female or Seed Parent.	Male or Pollen Parent.	Ancestral Pedigree.

Remarks on Variation, Size, Form, Colour, &c. :—

The Conference will open at Chiswick on Tuesday, July 11, at 12.45 P.M., when the guests of the Society will be received by the President, Sir Trevor Lawrence, Bart., V.M.H. Luncheon will take place at 1 P.M., after which the Conference will assemble for business at 2.15 P.M. and sit until 5 P.M.

On Tuesday, July 11, by the kind invitation of the Horticultural

Club, the foreign members of the Conference will be entertained at dinner at 6 for 6.30 P.M., under the presidency of Sir John D. T. Llewelyn, Bart., M.P., at the Hotel Windsor, Victoria Street, S.W. Morning dress.

On Wednesday, July 12, the Conference will re-assemble in the Westminster Town Hall, Caxton Street, Victoria Street, at 2 P.M. The Conference will close at 5 P.M.; after which the Society's distinguished foreign guests will be entertained at a banquet at the Whitehall Rooms of the Hôtel Métropole at 7 P.M., under the Chairmanship of Sir Trevor Lawrence, Bart., President of the Society. Reception of guests by Sir Trevor and Lady Lawrence at 6.30 punctually. Fellows wishing for tickets for the banquet (price 21s. each) for ladies or gentlemen should apply to the Secretary before July 5.

All persons interested in hybridisation or in cross-breeding are requested to assist by every means in their power, and are invited to send written information in the form of short notes for publication in the Report of the Conference to the Secretary, Rev. W. Wilks, 117 Victoria Street, Westminster.

All interested are invited, but special invitation has been sent to the following well-known hybridists and botanists; and apology is tendered to any whose names have been accidentally omitted :—

Bailey, Professor L. H., Cornell University, Ithaca, U.S.A.
Baker, Mr. W., The Botanic Gardens, Oxford.
Balfour, Professor J. Bailey, F.R.S., V.M.H., The Botanic Gardens, Edinburgh.
Bateson, Mr. W. M. A., F.R.S., Cambridge.
Beale, Mr. E. J., V.M.H., Teddington.
Bean, Mr. W. J., Kew Road, Richmond.
Benary, Herr F., Erfurt.
Bennett, Mr. Alfred, Cobham, Surrey.
Bennett-Poë, Mr. John P., Ashley Place, Westminster.
Bleu, Monsieur A., Avenue d'Italie, Paris.
Bonavia, Dr. E., Worthing.
Bunyard, Mr. G., V.M.H., Maidstone.
Burbank, Mr. Luther, San José, California, U.S.A.
Burbidge, Mr. F. W., M.A., V.M.H., The Botanic Gardens, Trinity College, Dublin.
Calvat, Monsieur E., Grenoble,
Chamberlain, The Rt. Hon. Joseph, M.P., Birmingham.
Chappellier, Monsieur P., Faubourg Poissonnière, Paris.
Cookson, Mr. Norman, Wylam-on-Tyne.
Cornu, Professor Maxime, Jardin des Plantes, Paris.
Crozy, Monsieur M., Rue de la Guillotière, Lyons.
Culverwell, Mr. W., Thorpe-Perrow, Yorks.
De Kerchove, Count Oswald, Biervelde, Ghent.
De Graaff, Herr Simon, Leyden.
De la Devansaye, Monsieur A., Noyant, Maine-et-Loire.
De Vries, Professor Hugo, The University, Amsterdam.
De Vilmorin, Monsieur Henry, Verrières-le-Buisson.
De Vilmorin, Monsieur Maurice, Quai d'Orsay, Paris.

Dewar, Mr. Daniel, Botanic Gardens, Glasgow.
Dickson, Mr. Alex., Newtownards, Ireland.
D'Ombrain, Rev. H. H., M.A., V.M.H., Westwell, Kent.
Douglas, Mr. James, V.M.H., Great Bookham, Surrey.
Druery, Mr. C. T., V.M.H., Acton.
Duval, Monsieur F., Rue de l'Hermitage, Versailles.
Eckford, Mr. H., Wem, Salop.
Elwes, Mr. H. J., F.R.S., V.M.H., Colesbourne, Gloucester.
Engleheart, Rev. G. H., M.A., Appleshaw, Andover.
Fairchild, Mr. D. G., Agricultural Department, Washington, U.S.A.
Farmer, Professor M. A., Royal College of Science, South Kensington.
Focke, Dr. W. O., The University, Bremen.
Foster, Sir Michael, K.C.B., Sec. R.S., V.M.H., Cambridge.
Fröbel, Herr Otto, Zürich.
Girdlestone, Mr. T. W., M.A., Sunningdale, Berks.
Hays, Professor Willett M., The University, Minnesota, U.S.A.
Heale, Mr. John, V.M.H., Chelsea.
Henriques, Professor, Coimbra, Portugal.
Henry, Monsieur L., Muséum d'Histoire Naturelle, Paris.
Henslow, Rev. Professor G., M.A., V.M.H., London.
Hooker, Sir J. D., F.R.S., V.M.H., Sunningdale, Berks.
Horner, Rev. F. D., M.A., V.M.H., Burton-in-Lonsdale.
Hudson, Mr. James, V.M.H., Gunnersbury.
Hurst, Mr. C. C., F.L.S., Burbage, Hinckley.
Jackman, Mr. A. G., Woking.
James, Mr. W. J., Farnham Royal.
Jouin, Monsieur E., Bronvaux, Metz.
Ker, Mr. R. Wilson, Liverpool.
Krelage, Herr E. H., Haarlem.
Laing, Mr. John, V.M.H., Forest Hill, Kent.
Latour-Marliac, Monsieur R., Temple-sur-Lot.
Lawrence, Sir Trevor, Bart., V.M.H., Burford, Dorking.
Laxton, Mr. W., Bedford.
Leichtlin, Herr Max, Baden-Baden.
Lemoine, Monsieur V., Nancy.
Lindsay, Mr. R., Murrayfield, Midlothian.
Llewelyn, Sir J. D. T., Bart., M.P., Swansea.
Lloyd, Mr. F. G., Langley, Slough.
Lowe, Mr. E. J., F.R.S., Shirenewton, Monmouth.
Ludwig, Professor F., The University, Greitz.
Lye, Mr. James, Easterton, Market Lavington.
Lynch, Mr. R. Irwin, The Botanic Gardens, Cambridge.
Macfarlane, Dr. J. M., The University, Philadelphia, U.S.A.
Maron, Monsieur C., Rue Montgeron, Brunoy, Seine-et-Oise.
Martin, Mr. J., Reading.
Masters, Dr. Maxwell T., F.R.S., London.
May, Mr. H. B., Edmonton.
Meehan, Mr. T., Germantown, Philadelphia, U.S.A.
Micheli, Monsieur Mark, Château du Crest, Jussy, Geneva.
Moore, Mr. F. W., V.M.H., The Botanic Gardens, Glasnevin, Dublin.

Morel, Monsieur F., Rue de Souvenir, Lyon-Vaise.
Moser, Monsieur J. J., Rue S. Symphorien, Versailles.
Naudin, Monsieur Charles, Antibes.
Nicholson, Mr. George, V.M.H., Royal Gardens, Kew.
O'Brien, Mr. James, V.M.H., Harrow.
Paul, Mr. George, V.M.H., Cheshunt.
Paul, Mr. William, V.M.H., Waltham Cross.
Pearson, Mr. A. H., Nottingham.
Pearson, Mr. C., Chilwell, Notts.
Penzance, the Right Hon. Lord, Esher.
Perby, Miss D. F. M., Cambridge.
Pfitzer, Herr W., Stuttgart.
Pynaert, Herr E., Ghent.
Rivers, Mr. T. Francis, V.M.H., Sawbridgeworth.
Robinson, Mr. W., Gravetye, Sussex.
Rolfe, Mr. R. Allan, The Herbarium, Kew.
Salter, Mr. C. J., Woodhatch, Reigate.
Sander, Mr. F., V.M.H., St. Albans.
Sargent, Professor C. S., The Arnold Arboretum, Mass., U.S.A.
Saunders, Miss E. R., Cambridge.
Schmidt, Herr Carl, Erfurt.
Seden, Mr. John, V.M.H., Chelsea.
Scott, Dr. D. H., M.A., F.R.S., Richmond, Surrey.
Shea, Mr. Charles E., Foot's Cray, Kent.
Simonite, Mr. Ben., Sheffield.
Smith, Mr. Martin R., V.M.H., Hayes, Kent.
Smith, Mr. Thomas, Newry, Ireland.
Smythe, Mr. W., Basing Park, Alton.
Strickland, Sir Charles, Bart., Hildenley, Yorks.
Stuart, Dr. Charles, Chirnside, N.B.
Sutton, Mr. Arthur W., F.L.S., V.M.H., Reading.
Swingle, Mr. W. T., Department of Agriculture, Washington, U.S.A.
Thiselton-Dyer, Sir William T., K.C.M.G., F.R.S., The Royal Gardens, Kew.
Trabut, Dr., Rue Desfontaines, Algiers.
Truffaut, Monsieur Georges, Avenue de Picardie, Versailles.
Veitch, Mr. Harry J., East Burnham Park, Slough.
Ward, Professor Marshall, F.R.S., Botanic Laboratory, Cambridge.
Waterer, Mr. F. G., Bagshot.
Watson, Mr. William, Royal Gardens, Kew.
Webber, Mr. Herbert J., Department of Agriculture, Washington, U.S.A.
Weeks, Mr. H., Thrumpton, Derby.
Whitton, Mr. J.
Wilks, Rev. W., M.A., Sec. R.H.S., Shirley, Surrey.
Wilson, Mr. G. F., V.M.H., F.R.S., Weybridge.
Wilson, Dr. J. H., The University, St. Andrews, N.B.
Wittmack, Professor L., The University, Berlin.
Wolley-Dod, Rev. C., M.A., V.M.H., Edge Hall, Malpas.
Yeld, Mr. George, M.A., York.

The Conference, it will be noticed, was preceded by one of the ordinary fortnightly meetings of the Society's Fruit, Floral, and Orchid Committees, held in the Great Vinery, for the details of which the reader is referred to the Society's Journal, vol. xxiii., pages cvi, cxxix, and clii.

A special exhibition of Hybrid Plants and their parents was held in the Great Vinery. The Awards made by the Council, together with a list of the more noticeable plants, are appended.

Awards made by the Council.

Gold Flora Medal.

To Messrs. James Veitch, of Chelsea, for Hybrid Orchids, Nepenthes, Saracenias, Rhododendrons, Ferns, Begonias, and Graft-hybrids.

Gold Medal.

To Monsieur Duval, of Versailles, for Hybrid Vriesias and Tillandsias.

To Monsieur Maron, of Brunoy, for Hybrid Orchids.

To Sir Trevor Lawrence, Bart., Burford Lodge, for Hybrid Orchids.

To Leopold de Rothschild, Esq., Gunnersbury House, for Hybrid Water-lilies.

To Messrs. H. B. May, of Edmonton, for Hybrid Ferns.

Silver-gilt Flora Medal.

To The Royal Gardens, Kew, for Kalanchoë flammea.

To Monsieur Morel, of Lyons, for Hybrid Clematis.

To Messrs. Jackman, of Woking, for Hybrid Clematis.

Silver-gilt Banksian Medal.

To C. T. Druery, Esq., V.M.H., Acton, for Hybrid Ferns.

Silver Banksian Medal.

To Professor Macfarlane, of Philadelphia, for a Hybrid Drosera.

To Herr Van Tubergen, of Haarlem, for Hybrid Lilies.

To Dr. Wilson, of St. Andrews, for Hybrid Passion-flowers, &c.

To Sir Frederick Wigan, Bart., East Sheen, for Hybrid Orchids.

To de Barri Crawshay, Esq., of Sevenoaks, for Hybrid Orchids.

To Messrs. Wallace, Colchester, for Hybrid Lilies.

To Messrs. Paul & Son, Cheshunt, for Hybrid Roses.

Other Awards.

Veitch Memorial Medal.

To Monsieur Duval, of Versailles (Class No. 6), for Bromeliads.

Williams Memorial Medal.

To Leopold de Rothschild, Esq. (Class No. 9), for Nymphæas.

First-class Certificate.

To Kalanchoë flammea, from the Royal Gardens, Kew. This new and strikingly beautiful plant from Somaliland is closely allied to the Crassulas. The flowers are of a bright red-orange, and continue a remarkably long time in bloom. The plant is about a foot or 15 in. high, stout, erect, branching, with thick fleshy leaves only slightly glaucous. It will probably require the same treatment as the Crassulas. (Fig. 1.)

Fig. 1.—Kalanchoë flammea.

LIST OF THE

PRINCIPAL HYBRID PLANTS EXHIBITED

ORCHIDS

CATTLEYA.

C. BREAUTIANA=*C. Loddigesii* ♀ × *C. superba* ♂. Raised by Mons. Maron, Brunoy, Paris; exhibited by Sir Trevor Lawrence, Bart.

C. GAUDII=*C. guttata Leopold* ♀ × *C. Loddigesii* ♂. Raised and exhibited by Mons. Maron. Crossed, April 11, 1894. Does not vary much.

C. PUNCTULATA=*C. Aclandiæ* ♀ × *C. intermedia alba* ♂. Raised and exhibited by Mons. Maron. Crossed, January 21, 1895.

C. 'ENID'=*C. Mossiæ* ♀ × *C. Warscewiczii* ♂. Raised and exhibited by Messrs. Veitch.

CYPRIPEDIUM

C. 'ALFRED HOLLINGTON'=*C. ciliolare* ♀ × *C. lævigatum* ♂. Exhibited by Messrs. Hugh Low, Bush Hill Park, Middlesex.

C. 'ALICE'=*C. Stonei* ♀ × *C. Spicerianum* ♂. Raised by Mr. Drewett, Riding Mill; exhibited by Messrs. James Veitch, 544 King's Road, Chelsea, and by Messrs. Low. Form, nearer the seed parent; colour, intermediate; habit, nearer the pollen parent.

C. ASHBURTONIÆ=*C. barbatum* ♀ × *C. insigne* ♂. Raised by Mr. Cross, Melchet Court; exhibited by Messrs. Veitch. Size, form, and colour, intermediate; habit, nearer the pollen parent.

C. 'CUPID'=*C. cardinale* ♀ × *C. Lindleyanum* ♂. Raised and exhibited by Messrs. Veitch. Size, form, and colour, nearer the seed parent.

C. DOMINIANUM=*C. caricinum* ♀ × *C. caudatum* ♂. Raised by Messrs. Veitch; exhibited by Sir Trevor Lawrence, Bart., Burford.

C. DRURIO-LAWRENCEANUM=*C. Lawrenceanum* ♀ × *C. Druryi* ♂. Raised and exhibited by Messrs. Veitch. Size and form, nearer the pollen parent; colour, intermediate; habit, nearer the seed parent.

C. 'ELEANOR'=*C. selligerum majus* ♀ × *C. superbiens* ♂ (C. selligerum majus=C. barbatum ♀ × C. Philippinense ♂). Raised by Mr. Drewitt; exhibited by Sir Trevor Lawrence, Bart.

C. 'EURYALE'=*C. Lawrenceanum* ♀ × *C. superbiens* ♂. Raised by Messrs. Veitch; exhibited by Sir Trevor Lawrence, Bart., and by Messrs. Veitch. Nearer the seed parent.

C. FRASERI=*C. hirsutissimum* ♀ × *C. barbatum* ♂. Raised by Messrs Veitch; exhibited by Sir Trevor Lawrence, Bart.

C. I'Ansoni giganteum=*C. Morganæ* ♀ × *C. Rothschildianum* ♂. Exhibited by Messrs. Low.

C. grande=*C. longifolium Hartwegii* ♀ × *C. caudatum* ♂. Raised

Fig. 2.—Cypripedium grande ×.

and exhibited by Messrs. Veitch. Size, form, and colour, intermediate; habit, nearer the seed parent. (Fig. 2.)

C. HARRISIANUM SUPERBUM=*C. villosum* ♀ × *C. barbatum* ♂. Raised and exhibited by Messrs. Veitch. This sprang from the same seed-capsule as C. Harrisianum, but its flowers are much larger and more richly coloured.

C. LAWRENCEANUM-MASTERSIANO=*C. Mastersianum* ♀ × *C. Lawrenceanum* ♂. Exhibited by Messrs. Low.

C. LEUCORHODUM=*C. longifolium Hartwegii* ♀ × *C. Schlimii albiflorum* ♂. Raised and exhibited by Messrs. Veitch. Size, form, and colour, intermediate; habit, nearer the seed parent.

C. MACROPTERUM = *C. superbiens* ♀ × *C. Lowii* ♂. Exhibited by Messrs. Low.

C. MARMOROPHYLLUM=*C. Hookeræ* ♀ × *C. barbatum* ♂. Raised and exhibited by Messrs. Veitch. Size, form, and colour, intermediate; habit, nearer the seed parent.

C. MILMANII=*C. Lawrenceanum* ♀ × *C. lævigatum* ♂. Exhibited by Messrs. Low.

C. MORGANIÆ=*C. Stonei* ♀ × *C. superbiens* ♂. Raised by Messrs. Veitch; exhibited by Messrs. Veitch and by Messrs. Low. Size, larger than either parent; form and habit, nearer the pollen parent; colour, intermediate.

C. ORPHANUM=*C. barbatum* ♀ or allied sp. × *C. Druryi* ♂. Raised and exhibited by Messrs. Veitch. Parentage, uncertain.

C. 'PERSEUS'=*C. Lindleyanum* ♀ × *C.* × *Sedenii porphyreum* ♂. Raised and exhibited by Messrs. Veitch. Entirely intermediate.

C. 'Pluto' I.=*C.* × *politum* ♀ × *C. Boxalli-atratum* ♂ (C. politum = C. venustum × C. barbatum). Raised by Mr. Reg. Young, Sefton Park, Liverpool; exhibited by Mr. C. C. Hurst Burbage, Hinckley. Crossed, 1891; sown, 1892. Habit and form of leaf, nearer pollen parent. Colour, nearer C. venustum.

C. 'PLUTO' II.=[Identical with Pluto I.] Nearer venustum in colour of leaves.

C. 'PLUTO' III.=[Identical with Pluto I.] Habit, nearer the pollen parent. Colour of leaves, derived from C. Boxalli and C. venustum.

C. 'PLUTO' IV.=[Identical with Pluto I.] Habit, nearer the pollen parent. Colour of leaves, derived from C. Boxalli and C. barbatum.

C. 'PLUTO' V.=[Identical with Pluto I.] Form, nearer the pollen parent. Habit and colour of leaves, nearer C. venustum.

C. 'PLUTO' VI.=[Identical with Pluto I.] Habit, nearer the pollen parent. Colour of leaves, nearer C. venustum.

C. 'PLUTO' VII.=[Identical with Pluto I.] Habit and colour of leaves, nearer the pollen parent; form, nearer C. barbatum.

C. 'PLUTO' VIII.=[Identical with Pluto I.] Habit and form of

leaves, nearer the pollen parent; colour, derived from C. barbatum and C. venustum.

C. 'Pluto' IX.=[Identical with Pluto I.] Habit, derived from the pollen parent and C. venustum; colour of leaves, derived from C. Boxalli and C. barbatum.

C. 'Pluto' X.= [Identical with Pluto I.] Habit, identical with C. Pluto IX.; form, derived from C. Boxalli and C. barbatum; colour of leaves, derived from C. barbatum and C. venustum.

C. 'Pluto' XI.=[Identical with Pluto I.] Form of leaves, nearer C. barbatum; colour, derived from C. barbatum and C. venustum.

C. 'Pluto' XII.=[Identical with Pluto I.] Habit and form of leaves, nearer the pollen parent; colour, derived from C. Boxalli and C. venustum.

C. 'Pluto' XIII.=[Identical with Pluto I.] Habit, nearer C. venustum; form of leaves, nearer C. barbatum; colour of leaves, derived from C. Boxalli and C. venustum.

C. 'Pluto' XIV.=[Identical with Pluto I.] Habit and form of leaves, derived from C. Boxalli and C. barbatum.

C. 'Pluto' XV.=[Identical with Pluto I.] Habit and colour of leaves, derived from C. Boxalli and C. barbatum; form of leaves, derived from C. Boxalli and C. venustum.

C. 'Pluto' XVI.=[Identical with Pluto I.] Habit, nearer C. barbatum; colour and form of leaves, derived from C. Boxalli and C. barbatum.

C. 'Pluto' XVII.=[Identical with Pluto I.] Habit, nearer the pollen parent; form of leaves, derived from C. Boxalli and C. barbatum; colour of leaves, derived from C. Boxalli and C. venustum.

C. 'Pluto' XVIII.=[Identical with Pluto I.] Habit, nearer C. venustum; form of leaves, nearer C. barbatum; colour of leaves, derived from C. Boxalli and C. venustum.

C. 'Pluto' XIX.=[Identical with Pluto I.] Habit, nearer C. barbatum; form and colour of leaves, derived from C. Boxalli and C. barbatum.

C. 'Pluto' XX.=[Identical with Pluto I.] Habit and form of leaves, derived from C. Boxalli and C. venustum.

C. 'Pluto' XXI.=[Identical with Pluto I.] Habit, derived from C. Boxalli and C. barbatum; form and colour of leaves, nearer C. Boxalli.

C. 'Pluto' XXII.=[Identical with Pluto I.] Habit and form of leaves, nearer C. barbatum; colour of leaves, derived from C. Boxalli and C. barbatum.

C. 'Pluto' XXIII.=[Identical with Pluto I.] Habit, derived from C. Boxalli and C. venustum; form of leaves, nearer C. barbatum; colour of leaves, nearer the pollen parent.

C. 'Pluto' XXIV.=[Identical with Pluto I.] Habit, nearer

C. venustum; form of leaves, nearer C. barbatum; colour of leaves, derived from C. barbatum and C. venustum.

C. POLITUM=*C. barbatum* × *C. venustum*. Raised by the late Mr. R. Warner, Broomfield, Chelmsford; exhibited by Mr. C. C. Hurst. Colour of leaves, nearer C. venustum.

C. SEDENII CANDIDULUM=*C. longifolium* ♀ × *C. Schlimii albiflorum* ♂. Raised and exhibited by Messrs. Veitch, Size and colour, intermediate; form, nearer the pollen parent; habit, that of the seed parent.

C. SELLIGERUM MAJUS=*C. barbatum* ♀ × *C. philippinense* ♂. Raised and exhibited by Messrs. Veitch. From the same seed-capsule as C. selligerum, but a more robust plant with larger flowers of a brighter colour.

C. SUPERCILIARE=*C. barbatum* ♀ × *C. superbiens* ♂. Raised and exhibited by Messrs. Veitch. Size, form, and colour, intermediate; habit, nearer the pollen parent.

C. 'T. W. BOND'=*C. Curtisii* ♀ × *C. hirsutissimum* ♂. Exhibited by Messrs. Low.

C. VERNIXIUM=*C. Argus* ♀ (spotted foliage) × *C. villosum* ♂ (green foliage). Raised and exhibited by Messrs. Veitch. Size and colour, intermediate; form, that of pollen parent; foliage, green.

C. WARNHAMENSE=*C. Curtisii* ♀ × *C. philippinense* ♂. Raised by Mr. Lucas, Warnham Court, Horsham; exhibited by Sir Trevor Lawrence, Bart.

DENDROBIUM

D. RHODOSTOMA=*D. Huttonii* ♀ × *D. sanguinolentum* ♂. Raised and exhibited by Messrs. Veitch. Size, small; form, nearer the seed parent; colour, intermediate.

DISA

D. 'CLIO'=*D.* × *Veitchii* ♀ × *D. grandiflora* ♂. Raised and exhibited by Messrs. Veitch.

D. KEWENSIS=*D. grandiflora* ♀ × *D. tripetaloides* ♂. Raised by Mr. W. Watson, Royal Gardens, Kew; exhibited by the Royal Gardens, Kew, Sir Trevor Lawrence, Bart., and Messrs. Veitch. Size, form, and colour, intermediate.

D. LANGLEYENSIS=*D. tripetaloides* ♀ × *D. racemosa* ♂. Raised and exhibited by Messrs. Veitch.

D. VEITCHII=*D. grandiflora* ♀ × *D. racemosa* ♂. Raised and exhibited by Messrs. Veitch. Size, form, and colour, intermediate.

EPIDENDRUM

E. ELEGANTULUM=*E.* × *Endresio-Wallisii* ♀ × *E. Wallisii* ♂. Raised and exhibited by Messrs. Veitch. Size and form, intermediate; colour, very variable; habit, nearer the pollen parent.

E. O'BRIENIANUM=*E. evectum* ♀ × *E. radicans* ♂. Raised and

exhibited by Messrs. Veitch. Size and colour, intermediate; form and habit, nearer the pollen parent.

E. RADICANTE-VITELLINUM=*E. vitellinum* ♀ × *E. radicans* ♂. Raised and exhibited by Messrs. Veitch. Size and habit, intermediate; form, that of seed parent; colour, nearer the seed parent.

EPIPHRONITIS

E. VEITCHII=*Sophronitis grandiflora* ♀ × *Epidendrum radicans* ♂. Raised and exhibited by Messrs. Veitch. Size, somewhat larger than pollen parent; form, nearer the pollen parent; colour and habit, intermediate. (Fig. 8.)

EPI-LÆLIA

E.-L. CHARLESWORTHII = *Lælia cinnabarina* ♀ × *Epidendrum radicans* ♂. Exhibited by Messrs. Veitch. Size, near the pollen parent; form and habit, nearer the pollen parent; colour, intermediate.

LÆLIA

L. 'EUTERPE'=*L. Dayana* ♀ × *L. purpurata* ♂. Raised by Messrs. Veitch; exhibited by Sir Frederick Wigan, Bart., East Sheen.

L. NIGRESCENS=*L. pumila* ♀ × *L. tenebrosa* ♂. Raised and exhibited by Mons. Maron. Does not vary much.

L. 'STELLA'=*L. crispa* ♀ × *L. elegans Wolstenholmiæ* ♂. Raised and exhibited by Messrs. Veitch. Flower, larger than either parent; growth, nearer the pollen parent; form and colour, nearer the seed parent.

LÆLIO-CATTLEYA

L.-C. 'APHRODITE' = *Lælia purpurata* ♀ × *Cattleya Mendelii* ♂. Raised and exhibited by Messrs. Veitch. Size, equal to pollen parent; form and habit, nearer pollen parent.

L.-C. 'BERTHE FOURNIER'=*Lælia elegans* ♀ × *Cattleya aurea* ♂. Raised and exhibited by Mons. Maron. Crossed, July 16, 1891. All the plants obtained from this seed-pod differ *inter se*.

L.-C. CALLISTOGLOSSA=*Lælia purpurata* ♀ × *Cattleya Gigas imperialis* ♂. Raised and exhibited by Mons. Maron. Seedling, March 10, 1893. Some extra good forms came out of this seedling.

L.-C. CANHAMIANA=*Lælia purpurata* ♀ × *Cattleya Mossiæ* ♂. Raised by Messrs. Veitch; exhibited by Messrs. Veitch and by Sir F. Wigan, Bart. Size, form, and habit, those of seed parent; colour, intermediate.

L.-C. CANHAMIANA ALBIDA=*Cattleya Mossiæ* ♀ × *Lælia purpurata* ♂. Raised and exhibited by Messrs. Veitch. Size, form, and habit, those of seed parent; colour, intermediate.

L.-C. DUVALIANA=*Lælia purpurata* ♀ × *Cattleya speciosissima* var. *Luddemanniana* ♂. Raised and exhibited by Mons. Maron.

FIG. 3.—EPIPHRONITIS VEITCHII ×.

Crossed, July 7, 1894. The few plants which have bloomed at present all have the same intensely dark lip.

L.-C. 'EUDORA' = *Lælia purpurata Schroderæ* ♀ × *Cattleya Mendelli* ♂. Raised and exhibited by Mons. Maron. Crossed, March 5, 1892. Does not vary much in size and colour.

L.-C. 'EUDORA' SPLENDENS = *Lælia purpurata* ♀ × *Cattleya Mendelli* ♂. Raised by Mr. Ingram, Godalming; exhibited by Sir F. Wigan, Bart.

L.-C. EXIMIA = *Lælia purpurata* ♀ × *Cattleya labiata Warneri* ♂. Raised by Messrs. Veitch; exhibited by Messrs. Veitch, Sir F. Wigan, Bart., and by W. P. Burkinshaw, Esq., Hessle, Hull. Size, equal to pollen parent; form and habit, nearer the pollen parent.

L.-C. 'HIPPOLYTA' = *Cattleya Mossiæ* ♀ × *Lælia cinnabarina* ♂. Raised and exhibited by Messrs. Veitch. Size, intermediate; form and colour, nearer pollen parent; habit, nearer seed parent.

L.-C. INTERMEDIO FLAVA = *Cattleya intermedia* ♀ × *Lælia flava* ♂. Raised and exhibited by Mons. Maron. Crossed, March 5, 1894. Varies very much, especially in colour.

L.-C. MARTINETI = *Cattleya Mossiæ* ♀ × *Lælia tenebrosa* ♂. Raised and exhibited by Mons. Maron. Crossed, April 20, 1895. A few plants gave a very different colour, and were mentioned in the *Orchid Review* under the name of L.-C. Martineti var. flavescens.

L.-C. MOSSIÆ PURPURATA = *Cattleya Mossiæ imperialis* ♀ × *Lælia purpurata* ♂. Raised and exhibited by Mons. Maron. Crossed, May 6, 1892. Some forms are superior to others, but all of them keep the transparent veins in the divisions.

L.-C. RADIATA = *Lælia purpurata* ♀ × *Cattleya nobilior* ♂. Raised and exhibited by Mons. Maron. Crossed, May 21, 1894. A little variation in the colour of the lip.

L.-C. STELZNERIANO-HARDYANA (form, Henry Greenwood) = *Lælia elegans Stelzneriana* ♀ × *Cattleya Hardyana* ♂. Raised and exhibited by Mons. Maron. Crossed, July 18, 1893. Does not vary much in size and form of the flower, but varies in the colour.

L.-C. 'ZEPHYRA' = *Cattleya Mendelli* ♀ × *Lælia xanthina* ♂. Raised and exhibited by Messrs. Veitch. Size and colour, intermediate; form, nearer the seed parent.

MASDEVALLIA

M. 'AJAX' = *M. Chelsonii* ♀ × *M. Peristeria* ♂ (M. Chelsonii = M. Veitchiana × M. amabilis). Raised by Messrs. Veitch; exhibited by Sir Trevor Lawrence, Bart.

M. GAIRIANA = *M. Veitchiana* ♀ × *M. Davisii* ♂. Raised and exhibited by Messrs. Veitch. Size, form, and habit, nearer the pollen parent; colour, intermediate.

M. HEATHII = *M. Veitchiana* ♀ × *M. ignea* ♂. Raised by Miss Heath, Cheltenham; exhibited by Messrs. Veitch. Size, intermediate; form and colour, nearer the seed parent.

M. HINCKSIANA = *M. tovarensis* ♀ × *M. ignea* ♂. Raised by Captain Hincks, Thirsk, Yorkshire; exhibited by Sir Trevor Lawrence, Bart.

M. 'IMOGEN' = *M. Schlimii* ♀ × *M. Veitchiana* ♂. Raised and exhibited by Messrs. Veitch. Size and form, nearer seed parent; colour, intermediate; habit of blooming, like seed parent more than one flower on a spike.

M. PARLATOREANA = *M. Barlæana* ♀ × *M. Veitchii* ♂. Raised by Messrs. Veitch; exhibited by Sir Trevor Lawrence, Bart.

ODONTOGLOSSUM

O. COOKSONII, var. CRAWSHAYANUM = *O. Hallii* ♀ × *O. crispum lilacinum* ♂. Raised and exhibited by de B. Crawshay, Esq., Rosefield, Sevenoaks. Crossed, June 21, 1894; seed sown, September 18, 1895; germinated, March 6, 1896; bloomed, June 28, 1899. Has size of seed parent. The blotching of sepals divided by influence of pollen parent; petals have denticulated edge from pollen parent; lip quite intermediate, with a smaller apiculus than the seed parent.

O. EXCELLENS = *O. triumphans* ♀ × *O. Pescatorei* ♂ or *vice versâ*. Raised and exhibited by Messrs. Veitch. Size and colour, intermediate.

O. EXCELLENS SANDERÆ. Exhibited by Sir Trevor Lawrence, Bart. Supposed natural hybrid between O. Pescatorei and O. triumphans.

PHALÆNOPSIS

P. LÜDDE-VIOLACEA = *P. violacea* ♀ × *P. Lüddemanniana* ♂. Raised and exhibited by Messrs. Veitch. Size, exceeds either parent; form, that of pollen parent; colour, intermediate.

SOBRALIA

S. VEITCHII = *S. macrantha* ♀ × *S. xantholeuca* ♂. Raised and exhibited by Messrs. Veitch. Size, nearer the seed parent; form and colour, intermediate; habit, variable, some dwarfer than either parent.

SPATHOGLOTTIS

S. AUREO-VIEILLARDI = *S. Vieillardi* ♀ × *S. aurea* ♂. Raised and exhibited by Messrs. Veitch. Size and form, those of seed parent; colour, intermediate; habit, stronger grower than the pollen parent.

THUNIA

T. VEITCHII = *T. Marshalli* ♀ (white with yellow throat) × *T. Bensoniæ* ♂ (purple). Raised and exhibited by Messrs. Veitch. Size and form, equal to either parent; colour, intermediate.

VANDA

V. 'MISS JOAQUIM' = *V. teres* × *V. Hookeriana.* Raised by Miss Joaquim, Singapore; exhibited by Sir Trevor Lawrence, Bart. Which was the seed parent is not known.

FERNS

ADIANTUM

A. BAUSEI = *A. scutum* × *A. trapeziforme.* Raised by Mr. Bause, Anerley; exhibited by Messrs. Veitch. The strong habit and pale colour of A. trapeziforme; form of pinnules, as in A. scutum, but of drooping habit.

A. COLLISII = *A. scutum* × *A. gracillimum.* Raised by Mr. Bause; exhibited by Messrs. Veitch. Finely divided like A. gracillimum, and size of growth and colour of foliage of A. scutum. In every respect intermediate.

A. KERCHOVEANUM = *A. Henslovianum* × *A. diaphanum.* Raised by Mr. E. Pynaert, Ghent, Belgium; exhibited by Messrs. Veitch. Evergreen and compact in habit, like A. diaphanum; pinnules arranged like A. Henslovianum, and same shape.

A. LEGRANDII = *A. gracillimum* × *A. Pacottii.* Raised by Mr. Walleam Legrand, Ghent, Belgium; exhibited by Messrs. Veitch. Has the fine divisions of A. gracillimum, with compact habit of A. Pacottii.

ATHYRIUM

A. FILIX FŒMINA, var. CONGESTUM EXCURRENS = *A. f. f. congestum* × *A. f. f. excurrens.* Parents both wild. Raised by Messrs. F. W. & H. Stansfield, Sale, near Manchester; exhibited by Mr. C. T. Druery, 11 Shaa Road, Acton. Crossed, 1888–9. Excurrens, has all terminals truncate and thorned; congestum, is dense and dwarf, The cross shows both characters clearly combined.

A. FILIX FŒMINA COUSENSII PLUMOSUM = *A. f. f. percristatum Cousensii* × *A. f. f. plumosum.* Raised and exhibited by Mr. C. T. Druery. Crossed, about 1895. Cousensii, raised; plumosum, found. The long falcate pinnules and plumose character of plumosum has lengthened the parts and increased the foliose character of Cousensii.

DAVALLIA

D. INTERMEDIA = *D. Mooreana* × *D. decora.* Raised and exhibited by Messrs. Veitch. Habit, similar to D. decora (drooping); colour and division of fronds, like D. Mooreana.

LASTREA

L. DILATATA LEPIDOTA CRISTATA = *L. dilatata lepidota* × *L. dilatata cristata.* Raised by Messrs. F. W. & H. Stansfield; exhibited by Mr. C. T. Druery. Crossed, 1893. A very striking

chance cross; the crest transmitted, together with a slight expansion of the parts of lepidota.

LOMARIA

L. GIBBA PLATYPTERA = *L. gibba* × *Blechnum braziliense.* Raised and exhibited by Messrs. Veitch. Intermediate between the two parents, with dark colouring of fronds, as in B. braziliense; plant barren.

POLYPODIUM

P. AUREO-VULGARE=*P. aureum* × *P. vulgare.* Raised and exhibited by Messrs. Veitch. Habit and size of frond, intermediate between the two parents; colour, nearer that of P. vulgare than P. aureum; rhizome, like that of P. aureum.

P. NERIIFOLIUM CRISTATUM=*P. neriifolium* × *P. vulgare cristatum.* Raised and exhibited by Messrs. Veitch. Same habit as P. neriifolium, with fronds crested as those of P. vulgare cristatum; rhizome, similar to that of P. neriifolium.

P. NIGRO-GRANDICEPS=*P. nigrescens* × *P. vulgare grandiceps.* Raised and exhibited by Messrs. Veitch. Strong habit of P. nigrescens and with same arrangement of fructification; fronds, crested as in P. vulgare grandiceps; rhizome, similar to that of P. vulgare nigrescens.

P. SCHNEIDERII=*P. aureum* × *P. vulgare elegantissimum.* Raised and exhibited by Messrs. Veitch. Intermediate in every respect between the two parents. Plant exhibited showed foliage in all stages of development; rhizome, that of P. aureum; plant barren.

P. VULGARE, var. ELEGANTISSIMUM CRISTATUM=*P. v. elegantissimum* × *P. v. bifido-cristatum.* Parents both wild. Raised by Mr. Clapham, Scarborough; exhibited by Mr. C. T. Druery. Crossed, about 1886–7. A remarkable cross. P. v. elegantissimum partially reverts to normal, a feature seen in the cross, which partially reverts to the other parent bifido-cristatum instead, whose peculiar cresting is exactly transmitted. Compare P. Schneiderii for same feature derived from same parent.

P. No. V.=*P. sporodocarpum* × *P. neriifolium.* Raised and exhibited by Messrs. Veitch. Intermediate between the two parents; foliage divided as in P. neriifolium and colour intermediate.

POLYSTICHUM

P. ANGULARE, var. LINEARE POLYDACTYLUM=*P. angulare polydactylum* × *P. ang.* var. *lineare.* Polydactylum, found wild; lineare, raised. Exhibited by Mr. C. T. Druery. Crossed, about 1890. Very distinct combination. A type of a large number of crosses with the polydactylum parent, which invariably transmits its irregularities—*i.e.* occasional normal pinnæ.

P. ANGULARE DIVISILOBUM GRANDICEPS=*P. ang.* var. *stipulatum,* Carbonell × *P. ang.* var. *grandiceps,* Moly. Raised by Mr. Carbonell; exhibited by Mr. C. T. Druery. Stipulatum, raised; grandiceps, Moly, wild find, Dorset. A very remarkable combination of the stipulate character with the cresting, accompanied by a coarsening of the divisions.

P. ANGULARE, var. ROTUNDATO-CRUCIATUM=*P. ang.* var. *rotundatum* × *P. ang.* var. *cruciatum.* Parents both wild. Exhibited by Mr. C. T. Druery. The rounded pinnules of rotundatum are conjoined with the cruciate pinnæ of cruciatum; the upper half of frond is also only affected.

PTERIS

P. CHILDSII, parentage uncertain. Raised by Mr. Childs, Eltham; exhibited by Messrs. Veitch.

P. TREMULA SMITHIANA=*P. tremula* × *P. serrulata cristata compacta.* Raised by Mr. Smith, Worcester; exhibited by Messrs. Veitch. Habit of P. tremula, crested as in P. serrulata cristata compacta.

SCOLOPENDRIUM

S. CETERACH=*S. vulgare* × *Ceterach officinarum.* Both native species, normal. Raised by Mr. E. J. Lowe, F.R.S., Shirenewton, Chepstow; exhibited by Mr. C. T. Druery. An indubitable hybrid. The fronds are of Ceterach form, but modified by confluence at the tip and quite devoid of scales. The fructification near the base is in faced pairs, the sign manual of Scolopendrium.

S. VULGARE, var. CRISPUM LACERATUM=*S. v. crispum diversifrons* × *S. v. laceratum.* Both wild finds. Raised by Messrs. F. W. & H. Stansfield; exhibited by Mr. C. T. Druery. Crossed, 1892. The broad basal extension (sagittate) of S. v. laceratum is clearly conveyed, and in addition the peculiar corrugated surface of S. v. crispum diversifrons.

S. VULGARE, var. CRISPUM MURICATUM=*S. v. crispum fertile* × *S. v. muricatum.* Both wild finds. Raised by Mr. E. J. Lowe; exhibited by Mr. C. T. Druery. S. v. crispum fertile is frilled; S. v. muricatum is muricate. The cross is slightly frilled and muricate.

S. VULGARE, var. SUPRALINEATUM GRANDICEPS=*S. vulg.* var. *supralineatum* × *S. v. grandiceps.* Parents both wild. Raised by the late Col. A. M. Jones, Clifton; exhibited by Mr. C. T. Druery. An intentional cross, a clear combination of the grandiceps ramose cresting with the supralineate character. Note the raised line and crenate edge of supralineatum.

RHODODENDRONS

[All raised and exhibited by Messrs. Veitch of Chelsea.]

RHODODENDRON

R. 'AURORA'=*R. Crown Princess of Germany* ♀ × *R. javanicum* ♂.

R. BALSAMINÆFLORUM ROSEUM. Obtained from an unnamed seedling. The parent was a flower which had petaloid stamens and was fertilised with its own pollen. Rose, white, yellow, salmon, and carmine coloured varieties were obtained from the one pod of seed.

R. 'DIADEM'=*R. javanicum* ♀ × *R. Duchess of Edinburgh* ♂.

R. 'ENSIGN'=*R. multicolor* ♀ × *R. Duchess of Connaught* ♂.

R. 'IMOGENE'=*R. Teysmannii* ♀ × *R. Taylori* ♂.

R. 'INDIAN CHIEF'=*R. Crown Princess of Germany* ♀ × *R. javanicum* ♂.

R. JASMINIFLORUM CARMINATUM=*R. jasminiflorum* ♀ × *R. javanicum* ♂. Raised from two species; the white and orange produced a carmine-coloured flower in this instance, while in R. P. Royal the colour was pink. This plant resembles the seed more than the pollen parent.

R. 'LITTLE BEAUTY'=*R. Monarch* ♀ × *R. Malayanum* ♂. Exhibited to show enlarged foliage of pollen parent. The flowers are much larger than those of the pollen parent, but not so large as those of seed parent; colour deeper than that of the pollen parent.

R. LUTEO-ROSEUM=*R. Princess Alexandra* ♀ × *R. javanicum* ♂.

R. 'MAIDEN'S BLUSH'=*R. Princess Alexandra* ♀ × *R. Brookianum gracile* ♂. A cross between a white and an orange flowered species.

R. 'MONARCH'=*R. Princess Alexandra* ♀ × *R. Duchess of Edinburgh* ♂.

R. 'MRS. HEAL' (Multicolor Section)=*R. multicolor* ♀ (pale straw colour) × *R. Princess Beatrice* ♂ (light salmon). Partakes of habit of seed parent, but with white flowers. The only pure white flowered seedling raised.

R. NE PLUS ULTRA=*R. javanicum* ♀ × *R. Duchess of Edinburgh* ♂.

R. 'NEPTUNE' (Multicolor Section)=*R. Minerva* ♀ × *R. multicolor Curtisii* ♂.

R. 'NESTOR' (Multicolor Section)=*R. Teysmannii* ♀ × *R. Curtisii* ♂ (species).

R. 'OPHELIA'=*R. Princess Alexandra* ♀ × *R. javanicum* ♂.

R. 'PRESIDENT'=*R. Crown Princess of Germany* ♀ + *R. javanicum* ♂.

R. 'PRIMROSE'=*R. Maiden's Blush* ♀ × *R. Teysmannii* ♂.

R. 'PRINCESS ALEXANDRA' = *R. Princess Royal* ♀ × *R. jasminiflorum* ♂. The second hybrid raised of the javanico-jasminiflorum section.

R. 'PRINCESS ROYAL'=*R. javanicum* ♀ (deep orange) × *R. jasminiflorum* ♂ (white). The first hybrid raised of the javanico-jasminiflorum section. Flowers intermediate in size. Yellow and white produced pink flowers.

R. 'PURITY'=*R. Teysmannii* ♀ × *R. Taylori* ♂.

R. 'ROSE PERFECTION'=*R. Princess Alexandra* ♀ × *R. javanicum* ♂.

R. 'Ruby' (Multicolor Section)=*R. jasminiflorum carminatum* ♀ × *R. multicolor Curtisii* ♂. The pollen parent is a small flowered rosy-crimson species.

R. 'Scarlet Crown'=*R. Duchess of Edinburgh* ♀ × *R. javanicum* ♂.

R. 'Souvenir de J. H. Mangles' = *R. Crown Princess of Germany* ♀ × *R. javanicum* ♂. (Fig. 4.)

R. Taylori=*R. Princess Alexandra* ♀ × *R. Brookianum gracile* ♂. (R. Princess Alexandra=R. Princess Royal × R. jasminiflorum. R. Princess Royal=R. jasminiflorum × R. javanicum.)

Fig. 4.—Rhododendron 'Souvenir de J. H. Mangles.'

R. 'Yellow Perfection'=*R.* × *Lord Wolseley* ♀ × *R. Teysmannii* ♂ (species from Sumatra).

R. Unnamed (Multicolor Section) = *R. jasminiflorum carminatum* ♀ × *R. Curtisii* ♂.

R. Unnamed (Multicolor Section)=*R. Princess Frederica* ♀ × *R. multicolor Curtisii* ♂.

R. Unnamed (Multicolor Section) = *R. Princess Royal* ♀ × *R. Curtisii* ♂.

R. UNNAMED=*R. Princess Royal* ♀ × *R. Teysmannii* ♂.

R. UNNAMED=*R.* × *Lord Wolseley* ♀ × *Azalea indica Stella* ♂. This

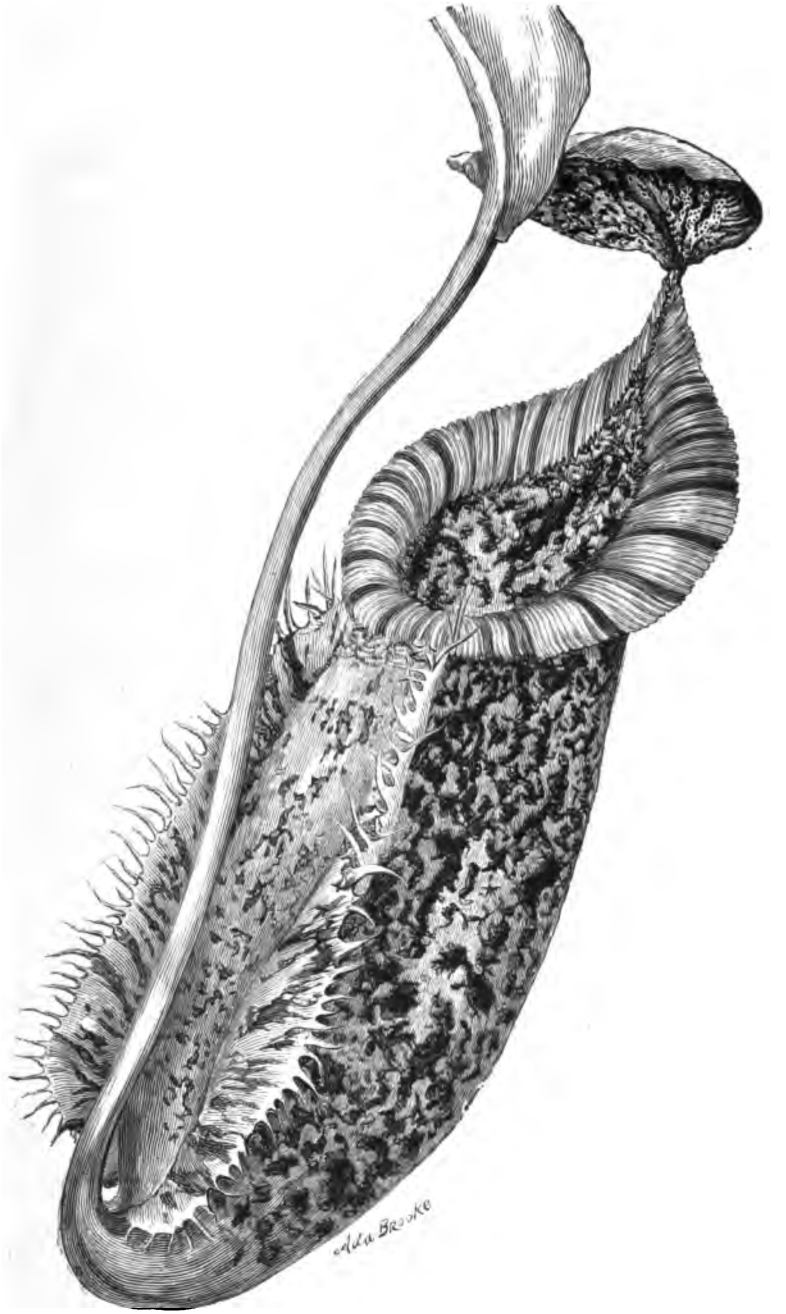

FIG. 5.—NEPENTHES DICKSONIANA.

plant, which is now only 3 in. high, is sixteen years old, having been raised in 1883.

R. UNNAMED=*R. Teysmannii* ♀ ×*R. Maiden's Blush* ♂.

R. UNNAMED (Multicolor Section)=*R. Teysmannii* ♀ ×*R. multicolor Curtisii* ♂.

PITCHER PLANTS

[Raised and Exhibited by Messrs. Veitch, of Chelsea.]

NEPENTHES

N. BALFOURI=*N.* × *mixta* ♀ × *N.* × *Mastersiana* ♂. Habit, intermediate; pitcher, intermediate in form and mottled; texture of pitcher, very leathery.

N. CHELSONI=*N. sp.* ♀ ×*N. Rafflesiana* ♂.

N. CYLINDRICA=*N. Veitchii* ♀ ×*N. hirsuta glabrescens* ♂.

N. DICKSONIANA=*N. Rafflesiana* ♀ ×*N. Veitchii* ♂. (Fig. 5.)

N. DOMINII=*N. sp.* ♀ ×*N. Rafflesiana* ♂.

N. FORMOSA=*N. Chelsoni* ♀ × *N. distillatoria* ♂.

N. HYBRIDA MACULATA=*N. sp.* ♀ ×*N. khasiana* ♂.

N. INTERMEDIA=*N. sp.* ♀ ×*N. Rafflesiana* ♂.

N. MASTERSIANA=*N. sanguinea* ♀ ×*N. khasiana* ♂.

N. MIXTA=*N. Northiana* ♀ ×*N. Curtisii* ♂. Partakes more of size of seed parent, and colour of pollen parent. (Fig. 8, p. 54.)

N. MORGANIÆ=*N. Phyllamphora* ♀ ×*N. Sedenii* ♂. Raised in America; exhibited by Messrs. Veitch. The Pitchers are much larger than in the pollen parent, but with colour of pollen parent intensified. (Fig. 6.)

N. SEDENI=*an unnamed species* ♀ ×*N. khasiana* ♂.

N. TIVEYI=*N. Curtisii superba* ♀ ×*N. Veitchii* ♂. Form, intermediate; colour, nearer the seed parent.

N. WITTEI=*N. Curtisii* ♀ ×*N. sp.* ♂.

N. WRIGLEYANA=*N. Phyllamphora* ♀ ×*N.* ×*Sedeni* ♂. Raised in America; exhibited by Messrs. Veitch. Pitchers, considerably larger than pollen parent; colour, nearer the pollen parent.

SARRACENIA

S. CHELSONI=*S. Mooreana* ♀ ×*S. purpurea* ♂.

S. COURTII=*S. purpurea* ♀ ×*S. psittacina* ♂.

S. EXONIENSIS=*S. purpurea* ♀ ×*S. crispata* ♂. Exhibited by Messrs. Veitch.

S. MELANORHODA=*S. Stevensii* ♀ ×*S. purpurea* ♂.

S. WRIGLEYANA=*S. Drummondi* ♀ ×*S. psittacina* ♂.

BROMELIADS

TILLANDSIA

T. DUVALI=*T. Lindeni major* × *T. Lindeni vera* var. *superba* Raised and exhibited by M. Duval & Sons, Versailles.

VRIESIA

[All raised and exhibited by Monsieur Duval, of Versailles.]

V. 'AURORA REX' = *V. Aurora* × *V. Rex*.

V. CARDINALIS = *V. brachystachys* × *V. Krameri*.

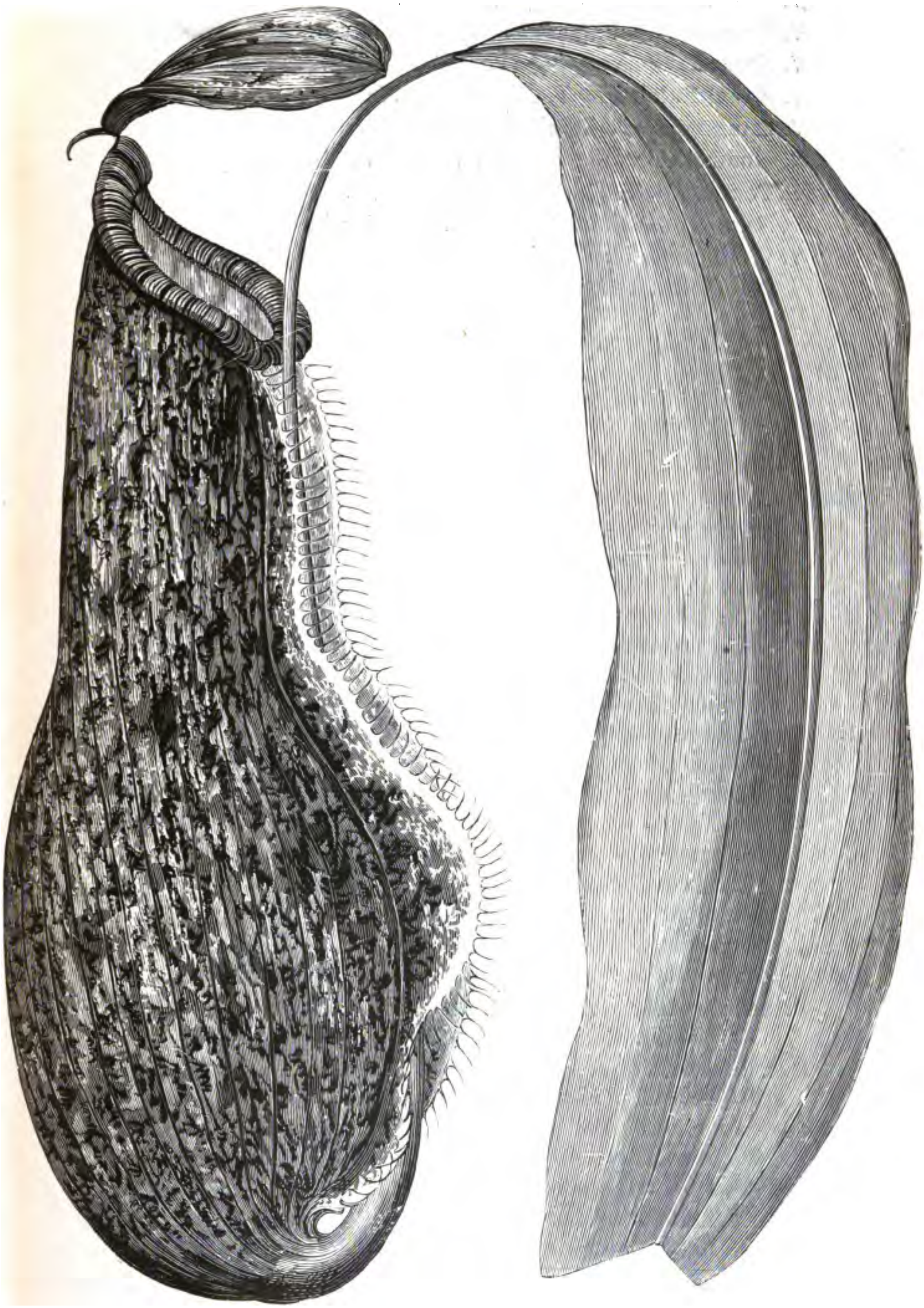

FIG. 6.—NEPENTHES MORGANIÆ.

V. Devansayana = *V. brachystachys* × *V. Krameri.*

V. fenestralo-fulgida = *V. fenestralis* × *V. fulgida.*

V. Henrici = *V. splendens* × *V. splendida.*

V. 'Imperator' = *V. Magnisiana* × *V. Rex.*

V. Kitteliana = *V. Saundersi* × *V. Barilleti.*

V. Kitteliano-conferta = *V. Kitteliana* × *V. conferta.*

V. Kitteliano-Rex = *V. Kitteliana* × *V. Rex.*

V. Magnifica = *V. Zahnii* × *V. splendens.*

V. Morenno-Barilleti = *V. Barilleti* × *V. Morenno.*

V. Poelmani = *V. gloriosa* × *V. Van Geerti.*

V. Rex = *V. Morenno-Barilleti* × *V. cardinalis.*

V. Rex nigrescens = *V. Morenno-Barilleti* × *V. Rex.*

V. Rex superba = *V. Morenno-Barilleti* × *V. Rex.*

V. 'Sphinx' = *V. Fenestralis* × *V. splendens major.*

V. Vassilliera = *V. Fenestralo-fulgida* × *V. Devansayana.*

V. Vigeri major = *V. Rodigasiana* × *V. Rex.*

V. Warmengi Rex = *V. Warmengi* × *V. Rex.*

BERBERIS

BERBERIS

B. stenophylla = *B. Darwinii* × *B. empetrifolia.* Raised by Messrs. Fisher & Sibray, Handsworth, Sheffield; exhibited by Mr. C. C. Hurst, Burbage, Hinckley. The original hybrid and parent of all the variations; 90 per cent. of which are true intermediates, and 10 per cent. variable.

[Raised and exhibited by Mr. C. C. Hurst, of Babage, Hinckley.]

B. stenophylla = *B.* × *stenophylla* ♀ × *B. stenophylla* ♂ (each parent = $\frac{1}{2}$ B. Darwinii $\frac{1}{2}$ B. empetrifolia). One of the 90 per cent. of true intermediate forms.

B. stenophylla I. = *B.* × *stenophylla* ♀ × *B.* × *stenophylla* ♂ (each parent = $\frac{1}{2}$ B. Darwinii $\frac{1}{2}$ B. empetrifolia). One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. stenophylla II. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. stenophylla III. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. stenophylla IV. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. Darwinii.

B. stenophylla VI. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. stenophylla VII. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. Darwinii. This is the most extreme form of all.

B. stenophylla VIII. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. stenophylla IX. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. STENOPHYLLA X.=[Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. Darwinii.

B. STENOPHYLLA XI.=[Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. STENOPHYLLA XII.=[Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. STENOPHYLLA XIII.=[Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. STENOPHYLLA XIV. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. STENOPHYLLA XV. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. Darwinii.

B. STENOPHYLLA XVI. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. STENOPHYLLA XVII. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. Darwinii.

B. STENOPHYLLA XVIII. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. Darwinii.

B. STENOPHYLLA XIX. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. Darwinii.

B. STENOPHYLLA XX. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. STENOPHYLLA XXI. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. STENOPHYLLA XXV. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. STENOPHYLLA XXX. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. STENOPHYLLA XXXIV. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. empetrifolia.

B. STENOPHYLLA XXXVI. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. Darwinii.

B. STENOPHYLLA XXXVII. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. Darwinii.

B. STENOPHYLLA XXXVIII. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. Darwinii.

B. STENOPHYLLA XXXIX. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. Darwinii.

B. STENOPHYLLA XLI. = [Identical with stenophylla I.] One of the 10 per cent. of extreme forms favouring B. Darwinii.

CINERARIAS

[Raised and exhibited by Mr. R. Irwin Lynch, Botanic Garden, Cambridge.]

SENECIO.

S. Heritieri × *S. cruentus*, Hort. Kew. non D.C.

S. Heritieri × florist's Cineraria.

S. multiflorus × *S. cruentus*, Hort. Kew.

S. multiflorus × *S. Heritieri.*

S. Tussilaginis × *S. cruentus*, Hort. Kew.

S. Tussilaginis B. × *Cineraria*, garden var.

ROSES

[All raised by Mr. G. L. Paul and exhibited by Messrs. Paul & Son, of Cheshunt.]

ROSES

R. UNNAMED=*Poly. Caroline Soupert* ♀ × *Fortune's Yellow* ♂. Crossed, 1890. Showing growth of pollen parent, but freer blooming and much hardier.

R. UNNAMED=*C. Soupert* ♀ × *Fortune's Yellow* ♂. Crossed, 1890. Habit of seed parent, valueless, does not open.

R. UNNAMED=*C. Soupert* ♀ × *Fortune's Yellow* ♂. Crossed, 1890. Growth of pollen parent.

R. UNNAMED=*Poly. C. Soupert* ♀ × *Fortune's Yellow* ♂. Crossed, 1890. Habit of pollen parent. Foliage, intermediate.

R. H. T. 'DAWN'=*Caroline Testout H. T.* ♀ × *Bourbon Mrs. Paul* ♂. Crossed, 1890. Very vigorous grower, intermediate in foliage. Habit similar to but stronger than pollen parent. Shape of almost single flower like pollen parent; colour and autumn flowering from seed parent.

R. H. P. 'ROYAL SCARLET'=*H. P. Cheshunt Scarlet* ♀ × *Marie Rady* ♂. Crossed, 1890. Habit and growth like seed parent. Spines and wood slightly after pollen parent and has the Marie Rady scent.

R. 'PSYCHE'=*Crimson Rambler* ♀ × *Golden Fairy* ♂. Crossed, 1894–5. Climbing habit of seed parent; flower, intermediate; colour, near pollen parent.

R. UNNAMED=*Crimson Rambler* (Poly) ♀ × *Tea Beauté inconstante* ♂. Crossed, about 1895. Climbing; showing variable colouring inherited from seed parent.

R. 'THE LION' = *Crimson Rambler* ♀ × *Beauté inconstante* ♂. Crossed, 1896. Vigorous climber; large flower, with character of seed parent.

R. UNNAMED=*Crimson Rambler* ♀ × *Tea Beauté inconstante* ♂. Very vigorous climber, slightly perpetual.

R. 'SCARLET CLIMBER'=*Pol. Crimson Rambler* ♀ × *Tea Beauté inconstante* ♂. Crossed, 1896. Strong climber, flowering to ground.

R. 'WALL FLOWER'=*Pol. Crimson Rambler* ♀ × *Tea Beauté inconstante* ♂. Flower, larger and looser than in seed parent; growth, leaves, colour, size, and autumn flowers from pollen parent.

R. Hyb. Bourb. 'J. B. M. CAMM'=*H. P. Me. Gabriel Luizet* ♀ × *Bourb. Mrs. Paul* ♂. Flowers, shape of seed parent. Habit wood, growth and foliage, nearer pollen parent.

CLEMATIS

[All raised and exhibited by Monsieur Morel, of Lyons.]

CLEMATIS

C. COCCINEO-MEGALANTHA=*C. megalantha No.* 140 ♀ × *C. coccinea* ♂. Colour, nearer the seed parent. Habit, similar to the pollen parent. This plant is always barren.

C. COCCINEO-PITCHERI=*C. Pitcheri* ♀ × *C. coccinea* ♂. All the plants from this cross are very similar, and almost intermediate between the parents. The flowers are earlier than Pitcheri, and have a scent like Vanilla.

C. 'FRANÇOIS MOREL'=*C. Star of India* ♀ × *C. Viticella rubro-grandiflora* ♂.

C. 'LA FRAÎCHEUR'=*C. No.* 137 (pale rose) ♀ × *C. Viticella alba* ♂. As strong growing as Viticella, but with large flowers.

C. 'ORIFLAMME'=*C. F. Morel* ♀ × *C. Viticella Kermesina* ♂. The markings of the sepals of the seed parent have been preserved, but on a much more vivid ground colour.

C. 'PERLE D'AZUR'=*C. lanuginosa cærulea* ♀ × *C. Viticella modesta* ♂. Very strong growing, forming shoots as strong as C. montana.

C. 'VILLE DE LYON'=*C. megalantha No.* 5 ♀ × *C. coccineo-Pitcheri* ♂. Plant very robust, but barren.

C. 'VILLE DE LYON' II.=*C. megalantha No.* 5 ♀ × *C. coccineo-Pitcheri* ♂. Plant exactly resembling the seed parent. The pollen parent seems to have done nothing but make the plant barren.

C. No. 401=*C. Oriflamme* ♀ × *C. coccinea* ♂. Foliage nearer the pollen parent, flowers nearer C. megalantha.

WATER-LILIES

[All raised by Monsieur R. Latour Marliac, Temple-sur-Lot, France, and exhibited by Leopold de Rothschild, Esq. (gr., Mr. J. Hudson).]

NYMPHÆA

N. AURORA.
N. CAROLINIANA.
N. C. NIVEA.
N. ELLISIANA.
N. GLORIOSA.
N. LAYDEKERI FULGENS.
N. L. LILACEA.
N. L. ROSEA.
N. LUCIDA.
N. MARLIACEA ALBIDA.
N. M. CARNEA.
N. M. CHROMATELLA.
N. M. FLAMMEA.
N. M. IGNEA.
N. M. ROSEA.
N. M. RUBRO-PUNCTATA.
N. M. SANGUINEA.
N. ORDORATA EXQUISITA.
N. O. SULPHUREA.
N. PYGMÆA HELVEOLA.
N. ROBINSONII.
N. SEIGNOURETI.

VARIOUS

ALOE

A. INSIGNIS=*A. drepanophylla* × *A. echinata.* Exhibited by the Royal Gardens, Kew.

A. UNNAMED=*A. latifolia* × *V. striata.* Exhibited by the Royal Gardens, Kew.

A. LYNCHII=*A. striata* × *A. verrucosa.* Exhibited by the Royal Gardens, Kew.

ANTHURIUM

A. FRAXINENSE OR FRAXINIANUM=*A. cordifolium* ♀ × *A. colocasiæfolium* ♂. Raised and exhibited by M. de la Devansaye, Angers. Crossed, 1895.

A. ROTHSCHILDIANUM=*A. Scherzerianum* ♀ × *A. Scherzerianum album* ♂. Raised by M. Bergman, Ferrières, France; exhibited by Messrs. Veitch. Flowers as large as those of seed parent; colour, intermediate, some being spotted more deeply and intensely than others.

BEGONIA

B. ACERIFOLIA=*B. Burkei* ♀ × *B. decora* ♂. Raised and exhibited by Messrs. Veitch.

B. 'BASING PARK HYBRID' = *B. weltoniensis* ♀ × *B. Scarlet Seedling* ♂. Raised by Mr. Wm. Smythe, Basing Park; exhibited by Mr. Wm. Smythe, Alton, Hants. Crossed, 1892. Flowers bright crimson, produced in great profusion; stand any amount of rough rainy weather. Compact grower. The tubers are distinct from the ordinary Tuberous Begonia, taking more after the seed parent.

B. 'EUDOXA'=*B. Burkei* ♀ × *B. decora* ♂. Raised and exhibited by Messrs. Veitch.

B. MARGARITACEA=*B. Arthur Mallet* ♀ × *B. coccinea* ♂. Raised and exhibited by Messrs. Veitch.

B. UNNAMED=*B. Burkei* ♀ × *B. Rex section* ♂. Raised and exhibited by Messrs. Veitch. Habit, that of seed parent, but stronger growing, the seedlings showing many shades of variegation.

BRAVOA

B. KEWENSIS=*B. geminiflora* × *B. Bulliana.* Exhibited by the Royal Gardens, Kew.

CALCEOLARIA

C. BURBIDGEI=*C. deflexa* (= *C. fuchsiæfolia*) ♀ × *C. Pavoni* ♂. Raised by Mr. F. W. Burbidge, V.M.H., Trinity College Botanic Gardens, Dublin. Crossed, 1879. Grows 10–15 feet planted out in cool greenhouse, 2–4 feet high in pots. Flowers, clear yellow, produced in autumn, winter, and spring. Coloured plate and history in *Garden*, May 4, 1895, p. 306.

CAMPANULA

C. BALCHINIANA = *C. isophylla alba* ♀ × *C. fragilis* ♂. Raised by Mr. William Mitten, Hurstpierpoint; exhibited by Mr. Richard Dean, Ealing, W. Crossed, 1892. (*C. isophylla alba*, a white variety of *C. isophylla*, a North Italian species; *C. fragilis*, species from South Italy.) *C. fragilis* is the earliest to bloom; *C. isophylla alba* is now showing bud; *C. Balchiniana* in the case of the plant shown blooms imperfectly; it is blue-flowered, like the pollen parent.

C. UNNAMED = *C. isophylla alba* ♀ × *C. pyramidalis alba* ♂. Raised and exhibited by Mr. E. H. Jenkins, of Hampton Hill. The habit of the hybrid was somewhat akin to typical *C. isophylla*, but in all other respects it differed from both parents. Its colour was a very curious shade of blue, both parents being white varieties of blue species.

DROSERA

D. HYBRIDA = *D. filiformis* × *D. intermedia*. Discovered and sent by Dr. Macfarlane, University of Pennsylvania, U.S.A. See longer notice in the "Proceedings of the Conference," p. 241.

HOLLYHOCK

H. 'PRIMROSE QUEEN' = *Althæa ficifolia* ♀ × *A. rosea* ♂. Raised and exhibited by Messrs. Veitch. (Fig. 7.)

HYMENOCALLIS

H. 'DAPHNE' = *H. speciosa* ♀ × *Ismene* (*Hymenocallis*) *calathina* ♂. Raised by Heer C. G. van Tubergen, jun., Haarlem, Holland. This hybrid was raised with the view of ascertaining the supposed origin of Hymenocallis macrostephana, which is considered to be H. speciosa × Ismene calathina. The result of this cross turned out to be a very different plant. Foliage of both the hybrid, its parents, and also that of H. macrostephana was sent. Unfortunately, the cross itself, H. 'Daphne,' was not then in flower.

KALO-ROCHEA

K. LANGLEYENSIS = *Kalosanthes coccinea* ♀ × *Rochea falcata* ♂. Raised and exhibited by Messrs. Veitch.

LILIUM

L. BURBANKI = *L. Washingtonianum* ♀ × *L. pardalinum* ♂. Raised by Mr. L. Burbank, California; exhibited by Messrs. R. Wallace & Co., Colchester. Only a weak spike from bulbs planted last March, and not sufficiently strong to show its free-flowering habit obtained from the seed parent.

L. DALHANSONI = *L. dalmaticum* ♀ × *L. Hansoni* ♂. Exhibited by Messrs. R. Wallace & Co.

L. MARHAN = *L. Martagon album* ♀ × *L. Hansoni* ♂. Raised by Heer C. G. van Tubergen, jun. Out of 500 seedlings of this cross, most of which turned out the ordinary purple-flowered

L. Martagon, about a dozen intermediate varieties appeared, of which a few of the most distinct are herewith being sent. Bulb, foliage, and everything else are intermediate between the parents.

It is especially noteworthy that although the white-flowered form of L. Martagon always comes true from seed, not one of

FIG. 7.—HOLLYHOCK 'PRIMROSE QUEEN.'

the seedlings of this cross turned out white—all, except about a dozen, reverted to the typical purple-flowered L. Martagon.

L. PARRYI × LEOPARD = *L. Parryi* ♀ × *L. pardalinum* ♂ (a dark small-flowered form). Raised and exhibited by Mr. J. Snow Whall, Worksop, Notts. Generally the plant seems midway between its parents, approaching the pollen parent in the

flower; the bulb, leaves, and shape of buds being nearer the seed parent. It has also the scent of the seed parent. The flowers are more numerous than in the seed parent, and the stem taller, being over 4 ft. on the tallest plant. The spikes sent have been grown in the open without protection. They are from one seed-pod, but differ somewhat in colour, markings, and colour of pollen-grains.

PASSIFLORA

P. KEWENSIS=*P. Raddiana* × *P. cærulea.* Exhibited by the Royal Gardens, Kew.

PELARGONIUM

P. 'HENRY JACOBY, VAR.'—Mr. Chas. E. Pearson, of Chilwell, Notts, sent a white variegated sport from P. 'Henry Jacoby.' This was very interesting, because the original 'Henry Jacoby' was the offspring of seed from a parent which had been crossed with white and variegated Pelargoniums with a view to raising new ornamental foliaged varieties. As is well known, 'Henry Jacoby' has a very dark-green leaf, and was raised more than thirty years ago, and now, after existing and being propagated for so long, the variegation endeavoured to be produced by the hybridising thirty years ago suddenly becomes apparent. The influence of the pollen parent had lain dormant thirty years. A similar sport occurred some few years ago, but was too delicate to rear.

TACSONIA.

T. MOLLISSIMA SPLENDENS = *T. mollissima* ♀ × *T. Smytheana* ♂. Raised by Mr. W. Smythe, Basing Park; exhibited by Mr. W. Smythe, Alton, Hants. Crossed 1891. The flowers are of much the same colour, but larger, and the plant is a much freer grower and distinctly more floriferous, producing flowers in great abundance.

T. SMYTHEANA = *T. mollissima* ♀ × *T. manicata* ♂. Raised by Mr. W. Smythe, Basing Park; exhibited by Mr. W. Smythe, Alton, Hants. Crossed, 1889. The colour is a bright scarlet, with a funnel-shaped tube of good length, 4 in. long. The flowers stand out conspicuously from the foliage, instead of having the drooping habit of the seed parent.

VARIOUS HYBRIDS,

Sent by the Rev. C. WOLLEY DOD, M.A., V.M.H., Edge Hall, Malpas, Cheshire.

I send a few out of many accidental (spontaneous) hybrids of hardy plants which have appeared in my garden in the last ten years. I have sent, where I have been able, flowers of the supposed parents.

I have added "fertile" or "barren" according to my own experience. I have found many hybrids fertile, but none constant from seed. I have never been able to obtain anywhere or to get authentic information of a true hybrid constant from seed. Many hybrids come of which it is hardly possible to say which is the seed parent, or what the hybrid is between. This is especially the case in Aquilegia and Dianthus. I may remark that in my garden, seed of *Dianthus cæsius*, saved from collected wild specimens, at once departs from the type, generally in the direction of the garden Pink, commonly called *D. plumarius*, but I suspect that *D. cæsius* is an important factor in garden Pinks. It passes in about three or four generations into a double garden Pink; it may of course be fertilised in every generation by the pollen of the garden Pink, said to be *D. plumarius*. The seed parent—and in most cases I have certain means of knowing—is the first on the labels of the specimens sent.

POLEMONIUM

Polemonium hybridises very freely; hybrids mostly barren, *P. cæruleum* × *P. reptans* seems to be an exception.

P. flavum × *P. cæruleum.*—These frequently come from seed of *P. flavum.* They may be at once recognised by feeling the heads after flowering. The hybrid has an empty calyx; the species *P. cæruleum* swells the seed pod directly.

P. cæruleum (var.) × *P. humile.*

ORCHIS

Orchis foliosa × *O. maculata.*—These come up by the side of clumps of *O. foliosa,* but like some other plants *all* the spontaneous seedlings are hybrid, and none ever comes *typical.*

HEUCHERA

Heuchera sanguinea × *H. cylindrica* (fertile).

,, ,, × *H. hispida* (fertile). I have raised seedlings from both these hybrids; they come gorgeous nondescripts.

CAMPANULA

Campanula rhomboidalis × *C. rotundifolia.*—I cannot be certain which is the seed parent, but where they grow together intermediate forms in every degree are endless. Many of them produce abnormal corollas; but these abnormal forms are not confined to hybrids.

LILIUM

Lilium Martagon, var. *dalmaticum* × *L. Hansoni* (fertile).—These have come in several parts of my garden from seed collected from *L. Martagon* in a frame, and sown broadcast. I send also a curious effect of a cross between *L. Martagon,* var. *dalmaticum,* and *L. Martagon* type, showing *mixed* flowers.

VERBASCUM

Verbascum phœniceum × *V. nigrum.*—*Barren* in my experience, but Mr. Lynch has sent me from Cambridge seed of V. *cupreum,* which is a

hybrid of the two named, and it has come up, but is not yet in flower. Godron, in "Flore de France," states that hybrids of Verbascum are always barren.

VEGETABLES

BEANS

Unnamed=*Smythe's Hybrid Dwarf* ♀ × *Runner Painted Lady* ♂ Raised by Mr. W. Smythe, Basing Park; exhibited by Mr. W. Smythe, Alton, Hants. Crossed, 1895. The flowers are of a scarlet colour, partaking of *Painted Lady*, with broad fleshy pods, and of fine flavour when cooked.

'Goliath'=*Smythe's Hybrid Dwarf* ♀ × *Champion Scarlet Runner* ♂ (*Canadian Wonder* × *Ne Plus Ultra*=*Champion Scarlet*). Raised by Mr. W. Smythe, Basing Park; exhibited by Mr. W. Smythe, Alton. Crossed, 1895. Flowers, light pink; thick fleshy pods of the Runner type. With its long racemes of flowers, they continue bearing through the season. Seeds black, and grows to a height of 2 ft.

'Scarlet Jubilee'=*Smythe's Hybrid Dwarf* ♀ × *Champion Scarlet Runner* ♂ (*Canadian Wonder* × *Ne Plus Ultra* = *Champion Scarlet*). Raised by Mr. W. Smythe, Basing Park; exhibited by Mr. W. Smythe, Alton. Crossed, 1895. This variety bears scarlet flowers like the Runner, and grows to a height of 18 to 20 in. The pods are of a thick fleshy character, and produce seed the colour of Scarlet Runner.

FRUITS

Raspberry 'Golden Queen' = *Raspberry Superlative* ♀ × *Rubus laciniatus* ♂. Raised and exhibited by Messrs. Veitch.

Rubus hybrid (Raspberry-Blackberry) = *Raspberry Belle de Fontenay* ♀ × *Rubus fruticosus* ♂. Raised and exhibited by Messrs. Veitch.

Strawberry 'Lord Kitchener'=*Waterloo* ♀ × *British Queen* ♂. Raised and exhibited by Messrs. Veitch.

LIST OF HYBRID GRAFTS

Exhibited at CHISWICK CONFERENCE by Messrs. JAMES VEITCH, of Chelsea, July 11, 1899.

a.	Athrotaxis	grafted on	Cryptomeria.
a.	Cotoneaster	,, ,,	Thorn.
a.	Photinia	,, ,,	Quince.
a.	Aucuba	,, ,,	Garrya.
a.	Garrya	,, ,,	Aucuba.
a.	Chionanthus	,, ,,	Fraxinus.
b.	Amelanchier	,, ,,	Pyrus Aucuparia.
a.	Olea	,, ,,	Ligustrum.
a.	Phillyrea	,, ,,	Ligustrum.
a.	Osmanthus	,, ,,	Ligustrum.
a.	Rhaphiolepis	,, ,,	Thorn.
a.	Lilac	,, ,,	Ligustrum.
c.	Lilac	,, ,,	Phillyrea.
b.	Genista	,, ,,	Laburnum.
a.	Cytisus	,, ,,	Laburnum.
a.	Ligustrum	,, ,,	Lilac.
c.	Magnolia	,, ,,	Liriodendron.
b.	Castanea	,, ,,	Quercus Robur.
a.	Ligustrum	,, ,,	Phillyrea.
a.	Osmanthus	,, ,,	Phillyrea.
a.	Rhaphiolepis	,, ,,	Cratægus Pyracantha.
a.	Cratægus	,, ,,	Quince.
a.	Eriobotrya	,, ,,	Rhaphiolepis.
b.	Eriobotrya	,, ,,	Quince.
a.	Choisya	,, ,,	Skimmia.
b.	Amelanchier	,, ,,	Thorn.
a.	Phillyrea	,, ,,	Olea.
b.	Pyrus japonica	,, ,,	Quince.
b.	Rosa Wichuriana variegata	,, ,,	Rubus.
a.	Elæagnus	,, ,,	Hippophaë.
a.	Cupressus nutkaensis	,, ,,	Biota orientalis.
c.	Kalmia	,, ,,	Rhododendron.
a.	Phillyrea	,, ,,	Osmanthus.

a. Doing well. *b.* Doing fairly well. *c.* Doubtful.

After the Exhibition a luncheon was given by the Council, to which all whose names appear on pp. 6–8 were invited, together with all the members of the Scientific, Fruit and Vegetable, Floral, Orchid, and Narcissus Committees; Sir Trevor Lawrence, Bart., President of the Society, being in the chair.

Luncheon ended, the President rose and proposed the toast of Her Gracious Majesty the Queen, Empress of India, patron of the Society. The toast was received with acclamation and drunk by all upstanding.

The President again rose and said: Ladies and Gentlemen,—I am sure that we, none of us, wish that the proceedings of the Conference should be delayed by speech-making, but there is one thing that I cannot deny myself the pleasure of doing, and it is this: on behalf of the Royal Horticultural Society to tender to all our friends who have gathered around us to-day, and especially to the gentlemen who have travelled from abroad on purpose to join in our Conference, a most hearty greeting and a most hearty welcome. I am sure that we are very grateful to those foreign friends whom we see around us, distinguished in horticulture and in botany, for their presence here to-day. We know that they have come at great expense and at no little inconvenience to join in our deliberations because, like ourselves, they are devoted to the science and the art of gardening. And we, we have been obliging enough to provide them with an almost tropical temperature, so that I do not think that when they go back to their own countries, even though they be countries ordinarily warmer than our own, they will any of them have cause to complain of any lack in the warmth of our reception. In this country, rightly or wrongly, we manage things somewhat differently to the way in which they are managed abroad. When we go abroad to gatherings of this sort we receive the most cordial and friendly—I might say the most magnificent hospitality at the hands of our horticultural friends; and this hospitality is extended to us not only by them but by the municipalities and by the Governments of the countries where the gatherings are held. I had the honour of being a Member of the House of Commons for several years, and I venture to wonder what would happen if I were to ask the Chancellor of the Exchequer to give the Royal Horticultural Society a grant to enable it to entertain its distinguished visitors in a due and worthy manner. I know very well what the result would be. But I am sure that, notwithstanding the unavoidable disadvantages of our position, no more cordial welcome could be extended to our foreign friends in any country than that which every Fellow of the Royal Horticultural Society now desires to convey to them through me. I hope therefore that our distinguished visitors will accept our apologies for all defects in our arrangements, and will make allowance for any shortcomings they may discern, resting assured that our one hope is that they may carry home with them such a sense of the sincerity of our British welcome as may induce them to give us the pleasure and the honour of seeing them again amongst us on many similar occasions.

As a proof of the cordial feeling entertained by our foreign friends for the horticulturists of this country I may mention that a letter has this moment been received announcing that it has pleased His Majesty the King of the Belgians to bestow the high honour of the Insignia of an

Officer of the Order of Leopold upon our distinguished friend Dr. Maxwell Masters, F.R.S., who is to take the chair at the first session of our Conference to-day.

The announcement of the honour conferred on Dr. Masters came as a complete surprise to all present, and was received with continuous rounds of cheering and applause.

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After the luncheon the first session of the Conference was held in a marquee on the lawn. (See p. 55.)

In the evening the foreign and distinguished guests were entertained at dinner, at the Hotel Windsor, Westminster, by the members of the Horticultural Club, under the presidency of Sir John D. T. Llewelyn, Bart., M.P. The dinner was of an informal nature, and was thoroughly appreciated by all present. The guests were delighted by the friendliness and enthusiasm of the greeting given them, one foreign Professor remarking that the dinner reminded him of his student days at the University, and that he had no idea the English could unbend so far; another writing afterwards, "As long as I am alive I shall remember that dinner at the Horticultural Club."

The heartiest thanks of the Royal Horticultural Society are due to the Horticultural Club for providing so enjoyable an evening for the Society's guests.

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The second session of the Conference was held on Wednesday, July 12, at 2 P.M., at the Westminster Town Hall. (See p. 127.)

In the evening a grand banquet was given by the Society to all the members of the Conference at the Whitehall Rooms of the Hôtel Métropole. The tables were most beautifully decorated with a profusion of the rarest and most exquisite flowers presented by Messrs. Cutbush, Laing, G. Paul, W. Paul, Sander, Turner, and Veitch. The thanks of the Society are due to these gentlemen, but more especially to Mr. James Hudson, V.M.H., who devoted the whole day to arranging them, and also contributed all the beautiful hybrid Water-lilies which were so universally admired. The magnificent fruit was contributed by Mr. Geo. Monro, V.M.H. It is due to both of these gentlemen to record that the authorities of the hotel bore witness that they had never in all their experience seen such a wealth of flowers and fruit, or any so beautifully arranged.

Covers were laid for 130, and, besides the foreign and distinguished members of the Conference (see pp. 6–8), the guests included His Excellency the Belgian Minister, His Excellency the Netherlands Minister, the Right Hon. Lord Justice Lindley, Master of the Rolls, the Right Hon. the Earl of Annesley, Sir Edward Fry, J. Rutherford, Esq., M.P., the Master and Wardens of the Worshipful Company of Gardeners, R. McLachlan, Esq., F.R.S., T. Dorrien-Smith, Esq., R. Milne-Redhead, Esq., Sidney Courtauld, Esq., and Mrs. Courtauld, T. B. Heywood, Esq., Dr. Fripp, N. N. Sherwood, Esq., and Miss Sherwood, Frederick G. Lloyd, Esq., and Mrs. Lloyd, J. Wigan, Esq., Charles E. Shea, Esq., Harry J. Veitch, Esq., the Rev. P. Edwards, M.A., the Rev. Geo. H. Engleheart, M.A., R. Gofton Salmond, Esq., and others.

The chair was taken by Sir Trevor Lawrence, Bart., President of the Society, who was accompanied by Lady Lawrence.

Dinner being ended, the following toasts were proposed:—

1. "Her Most Gracious Majesty the Queen and Empress."
(Patron of the Society.)
Proposed by the Chairman, Sir Trevor Lawrence, Bart.

2. "Horticulture."
Proposed by the Rev. Professor George Henslow, M.A., V.M.H., &c.
Responded to by Herbert J. Webber, Esq., Special Envoy from the United States Department of Agriculture.
Professer Hugo de Vries, Amsterdam University.
Monsieur Henry de Vilmorin, Horticultural Society of France.

3. "Hybridists."
Proposed by W. Bateson, Esq., F.R.S., Cambridge University.
Responded to by Monsieur de la Devansaye.
Walter T. Swingle, Esq., Washington, U.S.A.

4. "The Royal Horticultural Society."
Proposed by the Master of the Rolls (Lord Justice Lindley).
Responded to by the President of the Society (Sir Trevor Lawrence, Bart.)

5. "The Visitors."
Proposed by Charles E. Shea, Esq., Member of Council.
Responded to by His Excellency the Belgian Minister.

6. "The Chairman."
Proposed by Monsieur Mark Micheli, Geneva, Switzerland.
Responded to by Sir Trevor Lawrence, Bart. (President of the Society.)

In proposing the first toast, the President, Sir TREVOR LAWRENCE, said:—Your Excellencies, my Lords, Ladies, and Gentlemen,—The toast that I have to propose to you is "The health of Her Most Gracious Majesty the Queen, Empress of India, the Prince and Princess of Wales, and the Rest of the Royal Family." It is not necessary for me to say a single word about Her Majesty the Queen. During the many years that she has reigned over us we have become more devoted to her year by year. Her Majesty the Queen is the patron of our Society, and in years past Her Majesty's illustrious consort was President of the Society, and did all he possibly could to promote its welfare. With regard to Their Royal Highnesses the Prince and Princess of Wales, without claiming for them that they are special devotees of the art and science of horticulture, I have had the honour of escorting His Royal Highness and Her Royal Highness and the Duke and Duchess of York round the exhibitions of the Society at the Inner Temple and elsewhere on more than one occasion, and they have always expressed themselves highly delighted, as indeed they may well have been, with what they saw. I propose to you "The health of Her Gracious Majesty the Queen, Their Royal Highnesses the Prince and Princess of Wales, and the Rest of the Royal Family."

In proposing the second toast, the Rev. Professor HENSLOW said:— Your Excellencies, my Lords, Ladies, and Gentlemen,—No one can regret more than myself that I am speaking to you at the present moment. We hoped to hear Sir Michael Foster, Secretary of the Royal Society, on this occasion; but at the last moment, I regret to say, he is laid on a bed of sickness and cannot be with us to-night. Having been asked by Sir Trevor Lawrence, at a moment's notice, to take his place, you can imagine that it was with no

great feelings of pleasure that I undertook the responsibility. I thought, "What can I say about horticulture?" If I deal with it in its modern aspects I shall not know where to begin, what to say, or how to end. I thought, if I speak on the horticulture of past days, there is little or nothing left to be said. If we ask, what did the ancients know about horticulture—had they any ideas about horticulture as we have? we find a great gap, an absolute silence. All we can find about their gardens is that they were "herb" gardens. We have all heard of a certain king who robbed a man of his estate and turned it into a garden of herbs. We have all heard about the paradise of the Greeks, that consisted of trees, walks, and so forth. But when we turn to see what they did in the cultivation of flowers, it is extraordinary that history is perfectly silent. The great writers of the early centuries of this era, or a little before it, scarcely spoke of gardens at all. I think probably twenty-five varieties of plants would cover everything in their gardens; but then in their regions wild flowers were so abundant and beautiful that there was no necessity to grow flowers in their gardens. I remember Seneca, in denouncing the luxurious habits of the Roman nobles of his time, speaks of the extravagance of making dishes of larks' tongues, and adds that they literally stripped the fields of their flowers to adorn their feasts. Ovid speaks of a Rose garden, but I doubt whether this was more than a few wild Roses. When we come to the dark ages of the fifteenth century—(we hear of nothing before, except a few Lettuces and such things, though, that reminds me, the Romans were proud of their gardens, and some of the great families named themselves after Beans and Lettuces)—coming down to the middle ages, there is nothing to be said. In the sixteenth century, flowers at last began to be cultivated. But if we look at our own country, we do not find much in the way of flowers until the eighteenth century, and it is in the nineteenth century we get them coming in with a rush. The Chrysanthemums came dribbling in between the tens, twenties, and thirties of this century, and with a great rush in 1842. The Calceolarias also came in during this time. And then a few gardeners began to cross plants, which is the subject which brings us here to-night. The idea of crossing hitherto was unknown. The ancients were quite aware of it so far as the Palm was concerned. I mean the Date Palm; and we suppose that they artificially fertilised the Fig; but they knew nothing about the sexes of plants; they knew that if an enemy was in the country the first thing to be done was to cut down the male trees, so as to ruin the crop of Dates without having to destroy the Date-bearing trees. It is attributed to Sir Thomas Midleton that he first suggested that the pollen and stigma should be united to make seed. Linnæus took it up as you know; but it was not until Knight, the President of the Royal Horticultural Society, and Dean Herbert took up the subject of crossing that we entered on an entirely new field that transcends to-day everything else in the realm of horticulture. I have travelled as quickly as I could over that vast subject of "Horticulture" which has been entrusted to me, and I will only ask you to drink continued success to it, coupled with the names of those eminent exponents of it—Mr. Herbert J. Webber, of the Department of Agriculture and Horticulture of the United States of

America; Professor Hugo de Vries, of the University of Amsterdam; and Monsieur Henry de Vilmorin, Vice-President of the Société Nationale d'Horticulture de France.

Mr. HERBERT J. WEBBER :—Sir Trevor Lawrence, your Excellencies, my Lords, Ladies, and Gentlemen,—It gives me the greatest pleasure to have this honour of addressing you this evening, and I have furthermore pleasure in bringing to you across the seas the greeting—the most friendly greeting—of the Secretary of Agriculture of America, who has the greatest hopes for the future of horticulture and in the final development and advancement of all its allied industries, not only in America and the United States, but in the entire world. He looks upon our present condition as simply a formative one, and likely to lead to more important advancement and results, and in this I think the experience of this Conference bears our Secretary out. It seems to me, from what has been brought out at our meetings, that we are on the eve of a great advancement, and what has been done is simply a herald of the advance that is to come in the future. It is, however, a great misfortune, as was so forcibly brought out in our meeting this afternoon, that there is no way by which the originator of a new fruit or flower can reap the equivalent benefit. There is no doubt a certain amount of honour and pleasure and personal satisfaction in having originated something of this kind; but, after all, that is not quite sufficient reward. There should be more just and satisfactory recompense at the same time. How this can be brought about, gentlemen, is, of course, matter for consideration, but it lies with us to largely compensate the man—the originator of a new fruit or flower—to give him his just dues. It seems to me that the man who in any way lightens the struggle of humanity, or puts bread into the mouths of the starving, by improving our crops or giving us better yields, more appetising fruits or more delightsome flowers, is worthy of more honour than the man who invents a new pill, or a new kind of soap, or who writes a new novel; or than the man who makes war. After all, we should be at peace. We scientific men are at peace with one another. Science is an international thing. What we have to do is to popularise our work so that any development may meet with its just reward; and it seems to me I can look forward into the very near future and see the time rapidly approaching when a new discovery in horticulture in this land will meet its just recompense of reward.

Professor HUGO DE VRIES :—Mr. Chairman, your Excellencies, my Lord, Ladies, and Gentlemen,—One of the ideas of this Conference that has struck me most has been the desire to bring together men of science and of horticultural practice to exchange views. Almost all the papers showed clearly this tendency. Formerly there was very little feeling of community or of continuity between practice and science, but now on both sides this estrangement is being diminished, and the same sort of bonds that have brought engineering and electricity and all applied sciences to act together, in order to allow such magnificent results, must be brought into action in order to unite scientific and practical horticulturists in the realms of hybridisation. It seems that the objects we aim at are not to be so soon reached as we all wish. But what I have most enjoyed in this Conference is to see that feeling of fellowship

stretched far wider than I have ever known it before. The interest of your experiments are so wide that even zoologists have been brought to this Conference, and even they by attending to the work of the hybridist may gain some new light. The first paper we listened to yesterday was by Mr. Bateson, whose views, I believe, were founded on discontinuity in nature. Discontinuity is here the basis of continuity, for this gathering of different nations and sciences must needs lead to a greater union.

M. HENRY DE VILMORIN :—My Lords, your Excellencies, Ladies, and Gentlemen,—I feel it a duty to thank the Royal Horticultural Society of Great Britain for the compliment paid to myself and my country in being invited to this meeting—most opportunely called together by the Royal Horticultural Society. Too much cannot be said about the importance and the value of horticulture as a part of the national wealth of any country. Horticulture has been said to be, and is certainly, the highest and most perfect form of agriculture. It is the science that brings out the highest results from the soil, and that constitutes most of the wealth of any and every nation. But horticulture, like every economical undertaking, is at the present time working under difficulties. New competition and new difficulties are creeping up every year; and now when this century is waning and another is coming we have to be considering harder than ever how best to improve the condition of horticulture in every country in this world. The difficulties of horticulture, for example, are increasing in relation to the increased price of coals. We see in many parts of the world, and in this part in particular, that coals are used very largely for promoting the quick growth of plants, especially of fruit. But at the same time you see that the progress of navigation is so rapid that it is becoming an awkward problem in many cases whether it is more profitable to use coals to heat steamers to steam ten or fifteen miles an hour to bring fruit from distant countries, or to use the coal to bring forth earlier crops in our own countries at home. But if we could so alter the varieties of fruits that we could raise them by heat in a few weeks, then we should know what to do. It is to our hybridists, then, that we must look to make our old varieties earlier and able to be brought to maturity in a short time. Our efforts must be made to bring this about. Plants are our tools. They are the organs by which we obtain all precious results in horticulture. By improving our tools we are doing what all sorts of industry are trying to obtain—an improvement of their finished productions.

In proposing the third toast, that of "Hybridists," Mr. W. BATESON, F.R.S., said:—Mr. Chairman, your Excellencies, my Lords, Ladies, and Gentlemen,—I hardly knew to what I owed the honour of being chosen to propose this toast of "Hybridists" to-night until I recollected that perhaps I was the only man in the room who could say he had never produced a single hybrid. For this toast is practically the toast of ourselves. There must be very few here present who are not included in the term "hybridists." I think it is not difficult to anticipate that this toast will be drunk with alacrity. What is a hybridist? If you turn up the dictionary you find it is connected with the Greek word ὕβρις, which means "lawless." But in these two days that it has been my great

privilege to associate with hybridists from many parts of the world, I have come to believe there is no more law-abiding body to be found than the hybridists assembled here to-night. Their business is to find out what the law which governs hybridism and kindred phenomena is, and they are determined to do it. It is with the law that governs natural things as it is with the law of the land, you never know what it is until you get at the point of breaking it, if I may say so in the presence of one of Her Majesty's most eminent Judges. You must go on until you break the law, and then, at last, you know its limitations. The man who invented the metric system and incubators—the Chinese invented incubators, of course; but I mean the man who invented incubators we could use—in his interesting book, said one of the projects he set himself to carry out was to hybridise a rabbit and a fowl. But there, as Professor Henslow would say, his experiments in hybridisation failed. He found he had reached the confines of law. But without going so far as that there are many, many laws which we are perfectly certain we can find out, and which, if found out, would produce a most effective development in science and practice. It is the motto of our sister society, the Royal Agricultural Society, "Science with practice"; and a great deal has been said of the possibilities before us if we adopt this motto too. I believe the Agricultural society, in saying "science with practice," meant to imply that practice is to gain by its association with science. I am afraid that in hybridising all the gain is going to be on the side of science. If we could fully ally science with practice in horticulture, it seems to me that the gain would be all to science, for on the subject of hybridisation scientific people have little or nothing to tell us as yet. There was once a society that existed for the purpose of mending the clothes of the poor—darning and sewing on buttons, and so forth. Once an Irishman, of whom you may have heard, came to that society with a button in his hand and said, "If you would be so good as to sew a shirt to this button, I should be very much obliged." That is like science and practice in horticultural hybridisation. Science produces the button and practice has to bring the shirt. But by-and-by that will be all adjusted. Everybody knows how things began with electricity, chemistry, and so forth, and so it will be in horticulture and hybridisation. When I think of those who are to respond to this toast, Mr. Swingle, who is associated with that extraordinary development the Bureau of Agriculture in America, which has experiment stations all over that vast continent; when I think of the opportunities which they have which we in England have not, for in England, apart from private enterprise, there is nothing of the sort going on; when we think of all this, of the time that must elapse before equipment for scientific research can be set up, and any valuable results be gained, it is essential that some permanent record be made. As one sees sometimes in legal documents, "Time is of the essence of the contract." Without having the guarantee that these experiments will be carried on beyond our lifetime, many people think it is not worth while to begin them. We need a permanent home, so that the work that has been done will not be swept away into oblivion when we ourselves happen to go. Surely sooner or later someone will come forward and offer

this grand old Society such an establishment. I believe there is nothing that is so likely to revolutionise the scientific knowledge of animals and plants as such an establishment as I am speaking of would; and I think the best result of such a Conference as this is to stir up people's minds and make them think seriously of my suggestion. It is perfectly certain that there are great successes to be reached in these fields. I feel certain our experiments will not prove sterile, but will produce flowers and fruit which will be awarded by posterity with an "F.C.C." This means—I explain for the benefit of the uninitiated—that the fruit of this Congress will be hereafter judged and awarded a first-class certificate.

Monsieur DE LA DEVANSAYE (who spoke in French):—Sir Trevor Lawrence, your Excellencies, my Lords, Ladies, and Gentlemen,—It gives me the greatest delight to respond to this toast. Hybridisation has been one of the great pleasures of my life. I see in it the potentiality of quite an amazing extension of the world of plants, and that not in the very far distant future as world periods are reckoned. There appears to me to be practically no limit to what the hybridist may accomplish. Of course I mean no limit within that boundary of natural laws which Mr. Bateson has so humorously referred to. Gentlemen, I wish I could address you in your own language, but it is too hard for me. I thank you for inviting me to this most interesting Conference, and I hope it may be continued and reopened at our great Exhibition next year in Paris, when we shall be only too proud to give you as hearty a welcome in my country as we foreign guests have so heartily appreciated and enjoyed in yours.

Mr. WALTER T. SWINGLE, Department of Scientific Agriculture, Washington, U.S.A.:—It is with particular pleasure that I, a cousin from across the sea, rise on this occasion to respond to the toast of "Hybridists." It seems particularly appropriate that the Conference should be held in England, for it is in this island that Thomas Fairchild made the first hybrid known to the learned world. I don't think it was the first hybrid that existed, but it was the first hybrid known. It is also with particular pleasure that it is under the auspices of the Royal Horticultural Society, which has published the magnificent work of Dean Herbert, that I respond to this toast. It seems to me it is scarcely possible for us to over-estimate the future of the hybridist. When we recollect that scarce two hundred years ago Thomas Fairchild made the first hybrid ever known, and that now there have come people from all parts of the world deeply interested in the subject, and when we think of what a tremendous future there is for the improvement of our flowers, our fruits and foodstuffs, and all that appeals to our pleasure and our sense of beauty, we realise that hybridisation is the best and noblest branch of horticulture.

In proposing the toast of "The Royal Horticultural Society," Lord Justice LINDLEY, Master of the Rolls, said:—Mr. President, your Excellencies, my Lords, Ladies, and Gentlemen,—It will probably be a matter of some speculation and perhaps surprise that an old lawyer like myself should be invited to propose to you the toast of the Royal Horticultural Society. The reason is known to a few, and I will state it to those who are unaware of it. I am the bearer of a name which I am

proud to say was borne by a man who in his day for thirty-five years was the life and soul of the Royal Horticultural Society. I am not old enough to recollect the creation of the Society, for it was started in 1804; but I am old enough to recollect those days which were the glorious, prosperous days of the Society—the days of the great Chiswick *fêtes* in May, June, and July, when all the rank and fashion of London and the country went down to enjoy those great *fêtes*. They developed in my own time from that iron skeleton of a tent which used to stand in the arboretum of the Society till they culminated in those wonderful shows at Chiswick, and later on at Kensington. These were days when the Horticultural Society's exertions took the form of sending out explorers and collectors all over the globe, and the work they did was astonishing to those who are aware of their results. I recollect some of them. There was that fiery Douglas, who went out to Oregon and the Far West and met his death by being gored by a buffalo, as I recollect. Then I recollect Robert Fortune, a Scotchman, who, thanks to his high cheek-bones, his knowledge of Chinese, and his extraordinary dexterity with chopsticks, held his own in those outlandish Chinese places where he risked his life in order to obtain information. Those are the days that are past. Those are the days when money came in from the wealthy and from those who visited the Society. I recollect the time when the Emperor Nicholas was at Chiswick. There were more than 14,000 people present; and then came a time of depression. The Horticultural Society had certainly given an enormous spur to the life of gardening. But times were not prosperous. Chiswick Gardens were curtailed, and the arboretum had to be given up. Then we came to South Kensington, and there came again a time of outward prosperity, followed by a terrible blight. These tactics were changed. You appealed to scientific men rather than to the wealthy. You pursued a new course of utility. You adopted a distinctly horticultural policy with a lower rate of subscriptions, and, thanks to these things, but, above all, to the energy of your President, Sir Trevor Lawrence, and your hard-working and genial Secretary, Mr. Wilks, the Society now is entering upon a career which I trust will be as prosperous, if not more so than in the past. I have heard something about hybridisation, of which I know little. I have heard something which leads me to suppose that the development of that art may react upon the profession to which I have the honour to belong. Without being a prophet, I seem to see before me a vista of patent hybrids! What a treat for the patent lawyers! and what an accession of work for Her Majesty's Judges! I invite you to drink to the health of the Royal Horticultural Society as heartily as I have had the honour to propose it.

The Chairman (Sir TREVOR LAWRENCE):—The Master of the Rolls, your Excellencies, my Lords, Ladies, and Gentlemen,—I must confess it was with peculiar satisfaction that I received an intimation from the Master of the Rolls that he would give us the honour of his company here to-night. It is quite impossible for anyone who remembers the invaluable services which were rendered by his father to the Royal Horticultural Society and to the cause of the science of botany to do other than rejoice that a man who, like the Master of the Rolls, has made his mark in the world, though in a different direction from that of

his father, should be present here as our guest to-night. The Master of the Rolls has referred to some of the early parts of the history of this Society. The Society, as he has justly and correctly said, was founded in 1804, and our excellent and most energetic Secretary is already asking us how we are going to celebrate our centenary. There are numerous suggestions, and I am not going to trouble you with them to-night; but I think I may fairly claim for the Royal Horticultural Society that during the nearly hundred years that it has existed it has done very valuable work, not only in the cause of horticulture, but for the advancement of that which has given incalculable pleasure and delight to the people of this country. I very much wonder whether that very distinguished botanist, Sir Joseph Banks, in co-operation with Mr. Andrew Knight, whose name is so well known to hybridists, quite foresaw the very valuable work they were setting on foot when they met together at 187 Piccadilly, then occupied by Messrs. Hatchard, the booksellers, to inaugurate this Society. The objects of the Society were these, to foster and encourage every branch of horticulture and all arts and sciences connected with it. And when a few years later the Society had a Charter, a Royal Charter, granted to it, the objects were set forth very briefly—the improvement of horticulture in all its branches, ornamental as well as useful. As the Master of the Rolls has already told you, the Society in those early days sent out many collectors—not only those whom he has mentioned, but many others besides. I venture to think that when the Royal Horticultural Society sent Robert Fortune to China it was hardly aware that it was laying the foundation for the revolution of a great trade, for transferring to one country a great trade which up to that time had been the property of another country. I mean the shifting of the tea trade to a great extent from China to India. For it was owing to the fact that Robert Fortune was sent out by this Society to China that the cultivation of tea was undertaken in the Himalayas. It spread thence to Ceylon, and so, as we know, at the present time the great bulk of the tea which is consumed in Western countries comes, not from China, but from those countries into which Robert Fortune introduced it. With regard to the Scotchman who could not get out of the way of the bullock, he was gored to death in the Sandwich Islands, I believe. But with regard to Douglas he has introduced so many valuable plants that it is justly remarked his efforts and those of his colleagues have had marvellous results—results which have affected all parts of England. "For nowhere can a day's ride now be taken where the landscape is not beautified by some of the introductions of the Royal Horticultural Society." That is a quotation from a quarto volume which has some value, though not as much as it ought to have, by Mr. Andrew Murray, who wrote an account of the Royal Horticultural Society. The Master of the Rolls has referred to the Chiswick Shows. I have always been of opinion, and every day I live my opinion is strengthened, that when any society depends upon the somewhat fickle favours of fashion sooner or later it is certain to come to grief. So far as the fashionable world was concerned, as the Master of the Rolls has observed, it used at one time to favour Chiswick. Then something else attracted its attention, and at

the same time the elements were most unpropitious, and the Chiswick Shows came to an end. If the Royal Horticultural Society during recent years has had the advantage of greater prosperity, it has not been due, allow me to say, as I have been President for several years—it has not been due to the exertions either of the President or Council. It has been due to the fact that the President and Council of late years have adopted the only true policy, which is—to stick to horticulture. As long as any society, for which there is really any public demand—as long as it sticks to the subject which it is created to develop, so long will that society succeed. Our success, then, has been due, not to individuals, but to the policy inaugurated some twelve years ago, viz. that the Royal Horticultural Society existed, and should be considered to exist, wholly and solely for the promotion of scientific and practical horticulture. There is one thing with regard to the Congress we have been lately holding which I think has hardly perhaps been sufficiently recognised—that is the enormous obligation which the public owe to the hybridist and the horticulturist. There is scarcely a flower which grows in our gardens which has not been created, or which has not been enormously improved, by the work of hybridisation and selection. There is scarcely a fruit on our tables which we do not owe to the successes of the hybridist. Do you want early Strawberries? You get them. Do you want late Strawberries? You get them. All the result of hybridisation! If you want early or late Peaches you get them, the result of hybridisation. With Grapes it is the same; and so it is with vegetables, Peas, French Beans, Cauliflowers, Broccoli, Lettuces, you get them early and late—all the result of skilful hybridisation or of careful selection. I venture to think the public at large owe a great debt of gratitude to the horticultural profession for the enormous amount of work done in that direction. Well now, I do not wish to detain you any longer; but there is one thing I want to say before sitting down. The Royal Horticultural Society has no doubt been progressing of late years by leaps and bounds. We are now not far short of five thousand Fellows, a number which has never been approached in former times, but a number which, so far as I can see, will be by no means the limit of the popularity of the Society. We are not wealthy, but we are at all events in fair water. But we want two things. The Royal Horticultural Society wants a hall in London. If I had the good fortune to be addressing an audience not of my fellow-Londoners, but of the people of Manchester, or Liverpool, or one of our great northern cities, I believe in all probability some one would get up and say, "I will build you that hall." Now, is it impossible in this enormously rich metropolis that some gentleman who has had the greatest possible pleasure and delight from horticulture will come forward with some few thousands of his many millions and build us that hall? I cannot but believe that such a man will shortly appear. We want another thing—a new garden. Chiswick is too small, and too near London smoke. We want a garden which will be called, I hope, the New Chiswick; we cannot abandon the old name. We want a new garden, and for that we want money. I am thankful to say that the only card that has gone round the tables to-night is on behalf of the photographer. We are not going to send round the card to invite ladies and gentlemen to subscribe on

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this occasion; but if any lady—and I appeal more particularly to the ladies, for they are great admirers of flowers, and have a great influence on the opposite sex—if any lady present happens to have influence with any millionaire, I ask her to be good enough to urge the claims of the Royal Horticultural Society for a hall in London, and whether she succeeds or not, the Society will be deeply indebted to her. I wish, in conclusion, to say once more how grateful we are to our foreign friends who are gathered round us in such numbers to-day. I beg to thank the guests who have been good enough to be here to-night. This will be a red-letter day in the history of the Society, and I hope on some future occasion to have the great pleasure of seeing you all here again.

In proposing the toast of "The Visitors" Mr. CHARLES E. SHEA said:—I believe somewhere there is a telegram telling me I should have to propose the toast that Sir John Llewelyn had undertaken to propose. I had not the advantage enjoyed by Professor Henslow of receiving that telegram before I started, but on arriving I received the digestion-destroying command of the Secretary to take the place of Sir John. Of course the Secretary has made an enemy of me for life. But at the same time I felt that the toast was one that should be so easy, so pleasant, to propose that I accepted it. The occasion is graced to-night by the presence of many ladies, not only from England, but from abroad. Sir Trevor Lawrence has just laid a rather heavy charge on the ladies to build us a hall. Now they know what they have to do. Sir Trevor Lawrence has in his mind what we are all thinking—"the hand that rocks the cradle rules the world," and we of the Royal Horticultural Society would be the first to submit to and to admit the sweet sway which they have over us all. I do not think that we horticulturists altogether appreciate the great good which ladies have done for horticulture. We have to-night many distinguished visitors. We have the Ministers—the Belgian Minister, who is the representative of a country famed all the world over for its love of and its skill in horticulture. Then we have the Netherlands Minister, a keen friend of horticulture, who, in the Netherlands, holds the same position as Sir Trevor Lawrence does here. Time necessitates my passing by our English friends—Mr. Bateson, whose name we all know; Sir Michael Foster, whose absence, through illness, we all so much regret. But I will pass to the foreigners. We have among us no less than four representatives of our cousins across the water. We receive them to-night not only in their individual capacity, but as sent by the Government of the United States of America as a token of friendship and appreciation. We have Mr. Webber, Mr. Hays, Mr. Fairchild, and Mr. Swingle. France sends us many guests to-night—Monsieur de la Devansaye, the two Messieurs de Vilmorin, and others. Germany sends us again our friend Herr Schmidt, and we have from Holland our distinguished guest Professor Hugo de Vries and Herr Simon de Graaf. There are many others here that lack of time alone prevents me from mentioning. But let me deal for one moment with the impressions that the Conference has left on my mind. I think the impression our visitors will take back with them, as I shall take away with me, is the immense practical use of the Congress we have held. Our visitors, I think, will take back certain lessons.

They cannot help doing so. They, on their part, have taught us many lessons. I refer more to the American, because the Continental methods are so much more allied to our own that it is difficult to differentiate between ours and theirs. Perhaps we, of Europe, are too speculative and less practical than we ought to be. I admire scientific speculation tending towards the elucidation of first causes; but I was deeply impressed by the fierce, practical, utilitarian methods of the Americans, as Mr. Webber laid them before us this afternoon in a very strong and practical manner. Our American cousins know what they want, and they go straight at it. They get a "freeze" among the Oranges, and they say at once, "We must get Oranges that will withstand a frost," and they go straight at it. They try other Oranges and make a multitude of experiments towards the desired goal. Another point that has struck me very much, a point accentuated by Mr. Webber's lecture, was this—the large support which is given to the important matters of horticulture and agriculture by the Government of the United States. In our own country, if we went to the Chancellor of the Exchequer to ask for an extra hundred or so for Kew, we should be met by the usual official and departmental frown. Mr. Webber has told us that horticulture brings us all together, arouses in us those sympathies, those friendly feelings, which have been exhibited so largely the last few days. At the Hague there has been a conference with the object of making nations settle their disputes without going to war. It seems not to have suggested itself to the representatives of the Great Powers that there is one way which would render ironclads and Maxim guns drugs on the market—that all these nations should become Fellows of the Royal Horticultural Society.

His Excellency the Belgian Minister:—Mr. Chairman, my Lords, Ladies, and Gentlemen,—To be called upon to respond to the toast which you have just honoured is always regarded by every member of the body to which I belong not only as a matter of international courtesy, but as a very great personal pleasure. The exceedingly kind manner in which it was proposed and acknowledged encourages me to ask a yet further favour at your hands—that you will not take any poor words of mine as expressing my full sense of your kindness, and of the honour you have done to the visitors. This is no ordinary occasion. It is one which every one of us here will long remember for reasons which are common to us all. But each of us, no doubt, will have some special reason for its recollection. Speaking for myself, it will hold a leading place among my memories of all the kindness, all the hospitality, all the friendship that I have enjoyed since I first found myself at home among Englishmen. I say "at home" advisedly, for I know how much that word means here, and all that it means in England. It is, furthermore, our common diplomatic experience that British hospitality, not only in the special sense in which we enjoy it here this evening, but in the friendly offices of every day, is unsurpassed throughout the world. But, if this be true of the official representatives of all countries, how much more true must it be for the countries which are so specially and honourably represented here this evening. Speaking specially for the country and the Sovereign I have the honour to serve, I need not remind

you of the cordial friendship and admiration of that country for your own. You are aware also how deeply interested my august Sovereign is in all that concerns horticulture, to which he is very sincerely devoted, as it is also one of our national tastes. Gentlemen, I can now only ask you to accept our warmest thanks for this evening's welcome, and for the great honour you have conferred upon us by giving that welcome such cordial expression, and I fervently wish that our thanks could be as eloquent as they are sincere.

Monsieur Mark Micheli, of Geneva, Switzerland, in proposing the health of the Chairman, said:—Mr. Chairman, your Excellencies, and Gentlemen,—Allow me a very few words. At one time there was a little disagreement between botany and horticulture. Some botanists look down a little on horticulture; some look down a little on the horticultural varieties of plants. But what would be our garden—what would be the worth of the flower without the work of horticulture, and the work of the hybridist? We have many instances of it around us. These flowers that cover the table here are due to the horticultural art. It is due to the efforts of horticulturists that we have all these beautiful Water-lilies that are gracing our table, and now from a practical point of view the botanist can only look on the hybridist and horticulturist with very great satisfaction. From a practical point of view, hybridisation and horticulture are very useful to botany; but besides that from a scientific point of view, we have heard to-day at the meetings that the question of hybridisation might be treated from a scientific point of view, and we have had some papers which were of a scientific nature. One of the best ways to obtain our ends is by well-organised societies which will facilitate the work and help the workers on in their enterprise. I think not many societies are so well blessed as your Royal Horticultural Society, which is so ably directed by your most admirable President, Sir Trevor Lawrence, our Chairman to-night, to whom I am most happy to raise my glass, and invite you all to do likewise.

The toast was drunk with "three times three."

The Chairman:—M. Micheli, your Excellencies, my Lords, Ladies, and Gentlemen,—I am extremely obliged for the very kind way in which you have referred to the Society and to myself. I think I may venture to say on behalf of the Society that we greatly admire the fluency and the admirable way in which our foreign guests have spoken to us in English to-night. I am afraid when we have the honour of visiting Ghent, or Geneva, or Amsterdam, or wherever it may be, that we shall be unreasonable enough to expect the inhabitants of those countries to listen to our English speech. That reminds me. I have a son just going into the Army, and concerning him I had the honour of asking Lord Wolseley's advice. He said: "There are two things your son ought to be able to do—to ride very well and to speak foreign languages." I am afraid the latter art is not cultivated so much as it ought to be in this country. I am sure of one thing—that we are very grateful to our foreign guests for the very successful efforts they have made in expressing what they desired to say in our somewhat stubborn and difficult tongue. I can only repeat what I have said before, that we have been very pleased indeed to see the cordiality with which our foreign guests have come

round us. We appreciate their presence exceedingly. We know what valuable work they are doing in the cause of horticulture. We know what they have said about the Society has been said from their hearts, and we thank them most heartily for what they have said.

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The proceedings of the Conference were brought to a close by a most enjoyable Luncheon and Garden Party on Thursday, July 13, given by the Master of the Worshipful Company of Gardeners, Philip Crowley, Esq., F.L.S., F.Z.S., &c., &c., at his residence, Waddon House, near Croydon. Covers were laid for 120, and among the guests invited were the Right Hon. C. T. Ritchie, M.P., and Mrs. Ritchie, Sir Trevor Lawrence, Bart., and Lady Lawrence, Sir John Llewelyn, Bart., M.P., and Lady Llewelyn, Sir Frederick and Lady Edridge, Sir William and Lady Farmer, Colonel and Sheriff Probyn and Mrs. Probyn, the Mayor and Mayoress of Croydon, the Master of the Leathersellers' Company, the Rev. Canon and Mrs. Pereira, and all the foreign and distinguished members of the Conference.

Special trains conveyed the guests from London, setting them down at the very boundary of Mr. Crowley's gardens. Luncheon was served in a marquee, a military band being in attendance. After luncheon, Mr. Crowley received upwards of 250 guests at a Garden Party, and when the time came for the special train to convey the members of the Conference back to London all were agreed that a most delightful conclusion had been given to the Conference by the hearty welcome and unbounded hospitality of the Master of the Gardeners' Company.

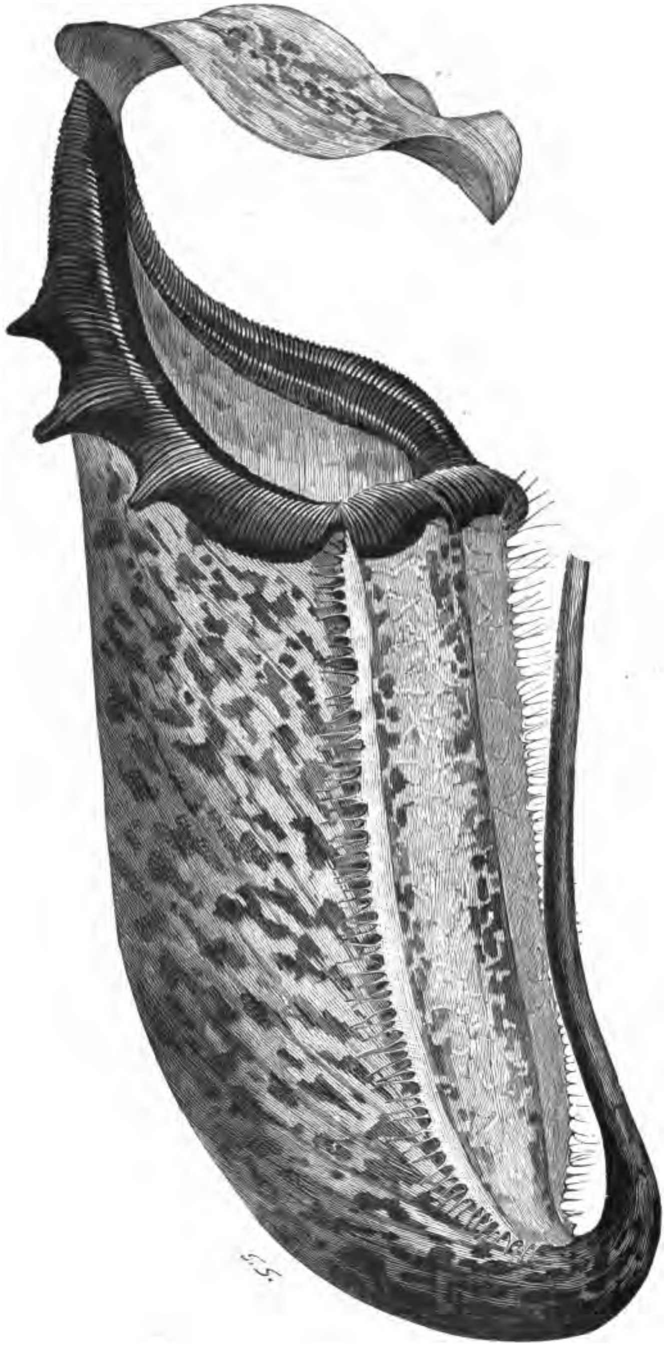

Fig. 8.—Nepenthes mixta. (*Journal of Horticulture.*)
(N. Curtisi × N. Northiana.)

CONFERENCE.

TUESDAY, JULY 11, 1899, AT CHISWICK.

Introductory Address by Dr. MAXWELL T. MASTERS, F.R.S., Officer of the Order of Leopold, &c., &c.

OUR first duty, and a very pleasant one it is, is to welcome our foreign guests, our friends from across the sea as I prefer to call them, to thank them for their presence here to-day, and to express a hope that their sojourn among us may be both agreeable and profitable. At the same time we regret that some such as Dr. Focke, the historian of hybridisation, has not been able to preside over this meeting, as we had hoped he might have done. Nor can we at such a meeting do other than express our abiding regret at the loss, though at an advanced age, of the great hybridiser, Charles Naudin.

Our next duty is to thank the Council of the Royal Horticultural Society for this opportunity of meeting once more in these time-honoured gardens to discuss what, I venture to think, is one of the, if not the most important subject in modern progressive experimental horticulture. I use the words progressive and experimental because I believe that the future of horticulture depends very greatly on well-directed experiment.

So far as the details of practical cultivation are concerned we are not so much in advance of our forefathers. We have infinitely greater advantages, and we have made use of them, but if they had had them they would have done the same. We are able to bring to bear on our art not only the "resources of civilisation" to a degree impossible to our predecessors, but we can avail ourselves also of the teachings of science, and endeavour to apply them for the benefit of practical gardening. We are mere infants in this matter at present, and we can only dimly perceive the enormous strides that gardening will make when more fully guided and directed by scientific investigations. One object of this Conference is to show that cultural excellence by itself will not secure progress, and to forward this progress by discussing the subject of cross-breeding and hybridisation in all their degrees, alike in their practical and in their scientific aspects.

To appreciate the importance of cross-breeding and hybridisation we we have only to look round our gardens and our exhibition-tents, or to scan the catalogues of our nurserymen. Selection has done and is doing much for the improvement of our plants, but it is cross-breeding which has furnished us with the materials for selection.

A few years ago by the expression "new plants," we meant plants newly introduced from other countries, but, with the possible exception of Orchids, the number of new plants of this description is now relatively few.

The "new plants" of the present day, like the Roses, the Chrysanthemums, the Fuchsias, and so many others, are the products of the gardener's skill. From Peaches to Potatos, from Peas to Plums, from

Strawberries to Savoys, the work of the cross-breeder is seen improving the quality and the quantity of our products, adapting them to different climates and conditions, hastening their production in spring, prolonging their duration in autumn.* Surely in these matters we have outdistanced our ancestors.

But let us not forget that they showed us the way. I do not propose to dilate on the share which Camerarius, Millington, Grew, Morland, and others at the close of the seventeenth century had in definitely establishing the fact of sexuality in plants; but I do wish to emphasise the fact that it was by experiment, not by speculation, nor even by observation, that the fact was proved; and I do wish to show that our English gardeners and experimenters were even at that time quite aware of the importance of their discovery, and forestalled our Herbert and Darwin in the inferences they drew from it. In proof of which allow me to quote from a work of Richard Bradley, called "New Improvements of Planting and Gardening, both Philosophical and Practical," published in 1717, cap. ii. After alluding to the discovery of the method of the fertilisation of plants, he says (p. 22):—

"By this knowledge we may alter the property and taste of any fruit by impregnating the one with the farina of another of the same class; as, for example, a Codlin with a Pearmain, which will occasion the Codlin so impregnated to last a longer time than usual, and be of a sharper taste; or if the winter fruits should be fecundated with the dust of the summer kinds they will decay before their usual time; and it is from this accidental coupling of the farina of one with the other that in an orchard where there is variety of Apples even the fruits gathered from the same tree differ in their flavour and times of ripening; and, moreover, the seeds of those Apples so generated, being changed by that means from their natural qualities, will produce different kinds of fruit if they are sown.

"'Tis from this accidental coupling that proceeds the numberless varieties of fruits and flowers which are raised every day from seed . . .

"Moreover, a curious person may by this knowledge produce such rare kinds of plants as have not yet been heard of by making choice of two plants for his purpose, as are near alike in their parts, but chiefly in their flowers or seed vessels; for example, the Carnation and Sweet William are in some respects alike: the farina of the one will impregnate the other, and the seed so enlivened will produce a plant differing from either, as may now be seen in the garden of Mr. Thomas Fairchild, of Hoxton, a plant neither Sweet William nor Carnation, but resembling both equally, which was raised from the seed of a Carnation that had been impregnated by the farina of the Sweet William."

Here we have the first record of an artificially produced hybrid, and you will remark that this was more than forty years before Kolreuter began his elaborate series of experiments. Fairchild was the friend and associate of Philip Miller, and of a small knot of "advanced" thinkers,

* See some interesting observations of MacFarlane on the period of flowering in hybrids as intermediate between that of the parents, *Gardeners' Chronicle*, June 20, 1891; and on the structure of hybrids, May 3, 1890.

and workers who banded themselves together into a "Society of Gardeners."

"He is mentioned," says Johnson in his "History of English Gardening," "throughout Bradley's works as a man of general information and fond of scientific research, and in them are given many of his experiments to demonstrate the sexuality of plants and their possession of a circulatory system. He was a commercial gardener at Hoxton, carrying on one of the largest trades as a nurseryman and florist that were then established. He was one of the largest English cultivators of a vineyard, of which he had one at Hoxton as late as 1722. He died in 1729, leaving funds for insuring the delivery of a sermon annually in the Church of St. Leonard's, Shoreditch, on Whit Tuesday, 'On the wonderful works of God in the Creation; or, On the certainty of the resurrection of the dead proved by the certain changes of the animal and vegetable parts of the Creation.'"

Fairchild was thus not only the raiser of the first garden hybrid, but the originator of the flower services now popular in our churches.

We do not hear much of intentionally raised hybrids from this time till that of Linnæus, in 1759.* The great Swedish naturalist having observed in his garden a Tragopogon, apparently a hybrid between T. pratensis and T. parvifolius, set to work to ascertain by experiment whether this conjecture was correct. He placed pollen of T. parvifolius on to the stigmas of T. pratensis, obtained seed, and from this seed the hybrid was produced.

About the same time (that is, in 1760) Kolreuter began his elaborate experiments; but these were made with no practical aim, and thus for a time suffered unmerited oblivion.

Some years after the President of this Society, Thomas Andrew Knight, and specially Dean Herbert, took up the work, with what splendid results you all know.

It is curious, however, to note that objections and prejudices arose from two sources. Many worthy people objected to the production of hybrids on the ground that it was an impious interference with the laws of Nature. To such an extent was this prejudice carried that a former firm of nurserymen at Tooting, celebrated in their day for the culture, amongst other things, of Heaths, in order to avoid wounding sensitive susceptibilities, exhibited as new species introduced from the Cape of Good Hope forms which had really been originated by cross-breeding in their own nurseries.

The best answer to this prejudice was supplied by Dean Herbert, whose orthodoxy was beyond suspicion. He, like Linnæus before him, had observed the existence of natural hybrids, and he set to work to prove experimentally the justness of his opinion. He succeeded in raising, as Engleheart has done since, many hybrid Narcissi, such as he had seen wild in the Pyrenees, by means of artificial cross-breeding. If such forms exist in nature, there can be no impropriety in producing them by the art of the gardener.

In our own time, Reichenbach, judging from appearances only, described as natural hybrids numerous Orchids. Veitch and others have

* *Amœn. Acad.*, ed. Gilibert, vol. i. p. 212.

confirmed his conjecture by producing by artificial fertilisation the very same forms which the botanist described.

It remains only to speak of another respectable but mistaken prejudice that has existed against the extension of hybridisation. I am sorry to say this has been on the part of the botanists. It is not indeed altogether surprising that the botanists should have objected to the inconvenience and confusion introduced into their systems of classification by the introduction of hybrids and mongrels, and that they should object to hybrid species, and much more to hybrid genera; but it would be very unscientific to prefer the interests of our systems to the extension of the truth.

I may mention two cases where scepticism still exists as to the real nature of certain plants: Clematis Jackmani of our gardens, raised, as is alleged, by Mr. Jackman, of Woking ("Gardeners' Chronicle," 1864, p. 825), was considered by M. Decaisne and M. Lavallée* to be a real Japanese species, and not a hybrid. This may be so, but there is no absolute impossibility in the conjecture that the Japanese plant and the cultivated plant originated in the same way. Again, Mr. Culverwell's hybrid between the Strawberry and the Raspberry has been pronounced to be no hybrid, but to be Rubus Leesii. But what, I may ask, is Rubus Leesii? It appears to be a sterile form more closely allied to the Raspberry than to the Strawberry. Is it not possible that Mr. Culverwell has produced it artificially?

The days when "species" were deemed sacrosanct, and "systems" were considered "natural," have passed, and Darwin, just as Herbert did in another way, has taught us to welcome hybridisation as one means of ascertaining the true relationships of plants and the limitations of species and genera.

Darwin's researches and experiments on cross-fertilisation came as a revelation to many practical experimenters, and we recall with something akin to humiliation the fact that we had been for years exercising ourselves about the relative merits of "pin eyes" and "thrum eyes" in Primroses, without ever perceiving the vast significance of these apparently trifling details of structure.

It would occupy too much time were I to dilate upon the labours of Gaertner, of Godron, of Naudin, of Naegeli, of Millardet, of Lord Penzance, of Engleheart, and many others. Nor need I do more than make a passing reference to the wonderful morphological results obtained within our own times by the successive crossings and intercrossings of the tuberous Begonias, changes so remarkable that a French botanist has even been constrained to found a new genus, Lemoinea, so widely have they deviated from the typical Begonias.

For scientific reasons, then, no less than for practical purposes, the study of cross-breeding is most important, and we welcome the opportunity that this Conference affords of extending our knowledge of the life history of plants, in full confidence that it will not only increase our stock of knowledge, but also enable us still further to apply it to the benefit of mankind.

* Lavallée, *Les Clématites à Grandes Fleurs*, p. vi and p. 9, tab. iv.: Clematis Hakonensis.

HYBRIDISATION AND CROSS-BREEDING AS A METHOD OF SCIENTIFIC INVESTIGATION.

By W. Bateson, M.A., F.R.S.,
University of Cambridge.

It was with a special pleasure that I accepted the kind invitation of the Council to address this Conference of persons interested in hybridisation. Of all the methods which are open to us for investigating the facts of Natural History there is perhaps none which is more likely to bring forth results of first-rate importance. Not only is the field a vast one, but the work is ready to hand. Though the patience and labour needed are very great, the practical methods are simple, and can be in many cases carried out by any person who has leisure and is able to carry out anything accurately. Leisure, accuracy, and a garden of moderate extent are almost the only equipment necessary for such work. On the other hand, the scientific importance of the results to be obtained is transcendent.

It is perhaps simpler to follow the beaten track of classification or of comparative anatomy, or to make for the hundredth time collections of the plants and animals belonging to certain orders, or to compete in the production or cultivation of familiar forms of animals or plants. But all these pursuits demand great skill and unflagging attention. Any one of them may well take a man's whole life. If the work which is now being put into these occupations were devoted to the careful carrying out and recording of experiments of the kind we are contemplating, the result, it is not, I think, too much to say, would in some five-and-twenty years make a revolution in our ideas of species, inheritance, variation, and the other phenomena which go to make up the science of Natural History. We should, I believe, see a new Natural History created.

It seemed to me that I could not better make use of this opportunity than by indicating, as far as I can, some of the *aims* which I think a worker in this field should put before him, and the class of work which, as it seems to me, is most likely to prove fruitful in bringing about the result I have indicated.

The problem, it is assumed, on which all such work is to be brought to bear is the *problem of species.*

I must ask you for a moment to consider the present position of knowledge in regard to Evolution and the nature of Species—for it is with a clear reference to the problem of species that breeding experiments, in the first instance, should, in my opinion, be undertaken. We see all living nature—animals and plants—divided into the groups which we call *species*, groups often so sharply marked off that there can be no doubt where they begin and end; groups often, on the other hand, so irregularly characterised that no two people would divide them alike. What are the causes that brought this about and keep it so? What are the facts underlying this phenomenon of *species*? For phenomenon it is; and, believe as we may that all these forms are related in

descent, there they are now, grouped into species as we know. How did this come about?

We all know the accepted view. We start from the fact that, since of all forms of life many more are born than can possibly survive, some —indeed, nearly all—must perish and leave no descendants. Next we observe the fact of Variation—that even the offspring of the same parents are never precisely alike, but vary. Now, since all cannot survive, it is clear that different individuals have a different chance of survival and of being represented by descendants. For each individual this chance will depend on the degree to which its structure and aptitudes fit it to bear its part in the struggle to which it is exposed. Briefly, *on the whole* the fittest will survive and breed.

Lastly, as the places in life that the organisms fit are diverse, so the forms of the surviving organisms are diverse too.

Everyone who cares at all for Natural History knows this reasoning, and knows also the difficulties by which its application to the facts of Nature is beset—how simple the theory seems when thus stated in general terms, but how hard it is to apply it in detail to a particular case.

Of all these difficulties the most serious are two. The first is the difficulty which turns on the magnitude of the variations by which new forms arise. In all the older work on evolution it is assumed, if the assumption is not always expressly stated, that the variations by which species are thus built up are *small*. But if they are small, how can they be sufficiently useful to their possessors to give those individuals an advantage over their fellows? That is known as the difficulty of *small or initial variations*.

The second difficulty is somewhat similar. Granting that variations occur, and granting too that if they could persist and be perpetuated species might be built up of them, how *can* they be perpetuated? When the varying individuals breed with their non-varying fellows, will not these variations be obliterated? This second difficulty is known as that of the *swamping effect of intercrossing*. Now on each of these two points the work of the hybridist and the experimental breeder comes in exactly. It is he who can see the variations arise, and can note their size and find out exactly how large they are—whether they are great or small—whether offspring do really differ but little from their parents, or whether, in certain cases and in respect of certain characters, the differences in variation may not be very great and definite; whether, also, the supposed swamping effect is a real one or not, or to what extent it is real, and in regard to what characters.

I need not tell a body of persons, most of whom have themselves made experiments of this kind, that in numberless cases both great and thoroughly definite variations do occur. This much every practical man now recognises. But we are far from knowing which kinds of variations may thus be definite and palpable, and which are not. All we know is that both large variations and small variations occur, some in one character and others in other characters, and that characters which in one species may vary greatly and suddenly, in other species vary only slowly or hardly at all. All this is a matter which comes daily under

the observation of the breeder—especially the cross-breeder of plants or of animals. It is to him that we look for first-hand evidence as to the *magnitude of variations.*

At this point a word of caution is needed. All those present are aware of the great and striking variations which occur in so many orders of plants when hybridisation is effected. As everyone knows, it is to those extraordinary "breaks" that we owe perhaps the majority of our modern flowers. Such, for example, are Narcissus, Begonia, Pelargonium, Gladiolus, Streptocarpus, a great number of Orchids, Rhododendron, the Cineraria, and the like. I mention the Cineraria, because I have personal knowledge of these hybrids, and because I notice that the view that our garden Cinerarias are not hybrids is being again repeated, in spite of the clear evidence, both of history and recent experiment, to the contrary.

With such cases in view some may be disposed to say: "Here are the great and striking variations we are seeking. These new forms are like new species—some would even take rank as new genera. May not the natural species have arisen in like manner by hybridisation?" The answer to this question, however, is almost certainly *No.* And herein I believe most, if not all, professed botanists and zoologists will agree. To go into the matter fully here is impossible; but for many reasons, most of which have often been repeated, there is, I think, no good evidence for supposing that any natural species, whether of animal or plant, arose by direct hybridisation. Tempting as it may at one time have been to hope that we should thus get a short cut to the origin of species, few, I think, are now sanguine of such an issue. It is not in this direction that we can look for that advancement in knowledge which I believe will surely come from the work of the cross-breeder.

I am far from saying that these striking hybrids are without scientific interest, or that they have no bearing on the problem of species. I wish only to say that it is pretty clear that they have not the direct bearing which they would have if it could be supposed that natural species arose as similar hybrids.

The interest in the cross-breeder's work lies, as I think, in a somewhat different field. Whatever view we adopt of the origin of species—provided that we believe in the doctrine of Descent at all—we believe that every species has been actually produced from something like itself in general, though different in some particular. Wherever these two closely allied varieties exist, the problem of species is presented in a concrete form: How did variety A arise from variety B, or B from A, or both from something else? This question involves two further questions:—

1. By what steps—by integral changes of what size—did the new form come into being?
2. How did the new form persist? How was it perpetuated when the varying individual or individuals mated with their fellows? Why did it not regress to the form from which it sprang, or to an intermediate form?

To those who admit this reasoning it will be clear that the whole question of the origin of species turns on the relationship of each species

or each variety to its *nearest allies*. We may not yet have an authentic case of a nascent species that will satisfy all doubts, but unquestionably we have lots of nascent varieties. If only we make it our business to observe the way in which these nascent varieties come into being, and especially what happens when these varieties are crossed with their nearest allies, we shall have material from which to answer the main questions of which the Species problem consists.

It is only quite lately that any systematic study of such variations has been undertaken from the point of view of the evolutionist, and already some very clear results have been perceived.

As the first difficulty in applying the doctrine of Descent turned on the magnitude of variations, so as soon as careful study of Variation is begun it is found that large and distinct variations are by no means rare, and that in certain classes of characters they are indeed the rule. To this class of variation, in which the variation is found already at its beginning in some degree of perfection, I apply the term *discontinuous*.

We are taught that Evolution is a very slow process, going forward by infinitesimal steps. To the horticulturist it is rarely anything of the kind. In the lifetime of the older men here present it is not Evolution but Revolution that has come about in very many of the best-known Orders of horticultural plants. Even the younger of us have seen vast changes. It may have seemed a slow process to individual men in the case of their own speciality. It may have taken all their lives to obtain and fix a strain; but in Evolution that is nothing. It is going at a gallop!

Whenever, then, it can be shown that a variation comes discontinuously into being, it is no longer necessary to suppose that for its production long generations of selection and gradual accumulation of differences are needed, and the process of Evolution thus becomes much easier to conceive. According to what may be described as the generally received view, this process consists in the *gradual* transition from one normal form to another normal form. This supposition involves the almost impossible hypothesis that every intermediate form has successively been in its turn the normal. Wherever there is discontinuity the need for such a suggestion is wholly obviated.

The first question was: How large are the integral steps by which varieties arise? The second question is: How, when they have arisen, are such variations perpetuated? It is here especially that we appeal to the work of the cross-breeder. He, and he only, can answer this question: Why do not nascent varieties become obliterated by crossing with the type form

If you study what has been written on these subjects you will find it almost always assumed that such blending and obliteration of characters is the rule in Nature Whole chapters have been compiled with the object of showing how, in a world in which there is such complete blending, evolution might still go on. There has been a word invented to expressly denote this kind of blending; the word is *Panmixia*, a word barbarously and incorrectly formed to denote an idea which is for the most part incorrect likewise. For if instead of abstract ideas the facts of cross-breeding are appealed to, it is found that so far from this blending

and gradual obliteration of character being the rule, it is nothing of the kind. In many characters, on the contrary, it is at once found on crossing that the varying character may be transmitted in as perfect a degree as that in which it was found in the parent. It need scarcely be said that there are many structures and conditions which do not thus retain any integrity when crossed, but there are very many that do. Which characters are thus unblending, and which blend, must be determined by careful cross-breeding; and this knowledge can be discovered in no other way.

The recognition of the existence of discontinuity in variation, and of the possibility of complete or integral inheritance when the variety is crossed with the type, is, I believe, destined to simplify to us the phenomenon of evolution perhaps, beyond anything that we can yet foresee. At this time we need no more *general* ideas about evolution. We need *particular* knowledge of the evolution of *particular* forms. What we first require is to know what happens when a variety is crossed with its *nearest allies*. If the result is to have a scientific value, it is almost absolutely necessary that the offspring of such crossing should then be examined *statistically*. It must be recorded how many of the offspring resembled each parent and how many showed characters intermediate between those of the parents. If the parents differ in several characters, the offspring must be examined statistically, and marshalled, as it is called, in respect of each of those characters separately. Even very rough statistics may be of value. If it can only be noticed that the offspring came, say, half like one parent and half like the other, or that the whole showed a mixture of parental characters, a few brief notes of this kind may be a most useful guide to the student of evolution. Detailed and full statistics can only be made with great labour, while such rough statistics are easily made. All that is really necessary is that *some* approximate numerical statement of the result should be kept. The horticulturist makes a cross: he is perhaps obliged by want of time and space simply to keep what he wants and throw the rest away; but sometimes surely he might put down a few words as to what that "rest" consisted of. If he would do so he would have the gratitude of many a student hereafter. On looking through the literature of hybridisation one is saddened by the thought that while so much skill and money and effort have been expended, for want of a very little more attention to recording immeasurable opportunities have been missed.

We have seen that it is likely that those experiments will be found the most fruitful which deal with the relationship subsisting between a given variety or species and its nearest allies. The essential problem of evolution is how any one given step in evolution was accomplished. How did the one form separate from the other? By crossing the two forms together and studying the phenomena of inheritance, as manifested by the cross-bred offspring, we may hope to obtain an important light on the origin of the distinctness of the parents, and the causes which operate to maintain that distinctness.

Useful contributions to the physiology of inheritance may no doubt be made by experimental crossing of forms only remotely connected. Such work, however, will not supply the particular kind of evidence

most needed. This can only be got by an exhaustive study of the results of cross-breeding between various forms whose common origin is not very distant. Such experiments must, besides, be repeated sufficiently often to give a fairly extensive series of observations on which to base conclusions. Anyone, therefore, who wishes to work on these lines would do well to restrict himself to an examination of the transmitting properties of a small group of closely allied varieties or species, and to explore these properties thoroughly within that group.

Cross-breeding, then, is a method of investigating *particular* cases of evolution one by one, and determining which variations are discontinuous and which are not, which characters are capable of blending to produce a mean form and which are not. It has sometimes been urged as an objection against this method of investigation that the results are often conflicting. It has been said that such work will only lead to accumulations of contradictory evidence. It is, however, in this very fact of the variety of results that the great promise of the method lies. When varieties and species are tested by this method it is found that their mutual relations are by no means alike, and properties are disclosed which can in no other way be revealed.

In illustration, I will refer to three cases of hairy and smooth varieties. In each case there is a well-marked discontinuity between the two varieties; but, as is shown by the evidence obtained by cross-breeding, the nature of the relationship* of the two forms to each other is different in each case, and the distinctness is maintained by different means.

The plants (produced at the meeting) illustrating the following observations were raised by Miss E. R. Saunders, of Newnham College, Cambridge, who is carrying out a large series of experiments on this subject.

The first case is that of *Matthiola incana*, a hoary species, and its smooth variety known in gardens as the Wallflower-leaved Stock. Experiments in crossing these two forms were made by Trevor Clarke, and briefly described by him in "Report of Botanical Congress," 1866. Amongst other things his investigations showed that on crossing these two varieties the offspring consisted entirely of completely hoary and completely glabrous individuals, no intermediate being present. Miss Saunders's work entirely confirms this result. The type-form used by her was procured from seed of presumably wild specimens growing in the Isle of Wight. The glabrous variety was the ordinary garden form the origin of which is not known to us. In this case discontinuity is manifested in its simplest form.

The second example is that of *Lychnis diurna*. There, again, the normal is hairy. A glabrous variety was found by Professor de Vries, and was by him crossed with the type. All the first generation of crossbreds inherited the hairiness in its complete form. When, however, these plants were crossed again with the smooth form, the result was a mixed progeny, of which some were hairy and others smooth. The same result

* The term "relationship" is somewhat misleading, but I cannot find a better. It is used to denote not simply the blood-relationship of the forms to each other, but those physiological relations subsisting between them which are manifested by experimental crossing. The word is thus used in a sense similar to that which it bears when we speak of the chemical relations of one substance to another.

also occurred when the cross-bred plants were bred with each other. Professor de Vries kindly sent seed of his glabrous form to Cambridge, where Miss Saunders repeated the experiments with the same results. In all the cases of mixed progeny there is a sharp discontinuity.

The third case is that of *Biscutella lævigata*. A full account of this important case was published by Miss Saunders in "Proc. Roy. Soc." 1897, vol. lxii. p. 11. Briefly the facts are as follows. The species is common as a hairy plant throughout a great part of the Alps. In a few localities a variety occurs having the *surfaces* of the leaves quite devoid of hairs. (There are almost always some hairs on the margins and leaf-teeth.) When present, this smooth form occurs abundantly, mixed with the hairy type. Intermediates are of rare occurrence. If plants of the two kinds breed freely together, as in the natural state we must suppose they do, how is the sharp distinction in their respective characters maintained? The result of artificial cross-breeding went to show that of the young seedlings of mixed parentage some were hairy, some smooth, and a good many intermediate. But as these seedlings grew, the hairy and the smooth retained their original characters, while the intermediate ones gradually became smooth. The transition was not effected by actual loss of hairs, but after the first few leaves of intermediate character the leaves subsequently produced were smooth.

In all these three cases there is discontinuity, the intermediates between the varieties being absent or relatively scarce. Nevertheless, on examination it is found that the discontinuity is not maintained in the same way in the different cases. The transmitting powers of the one variety in respect of the other are quite different in each case, and it must, I think, be admitted that we have here a fact of great physiological significance. In each of the three cases enumerated the two varieties are seen to stand towards each other in a different relation, and in each the mechanism of inheritance works differently.

From facts like these we perceive how imperfect is the survey of the characteristics of species and varieties which can be obtained by the ordinary methods of anatomy and physiology. There can be no doubt that, tested by the method of breeding and by study of the transmitting powers, the relation of varieties and species would be shown in an entirely new light. We are accustomed to speak of "variability" as though it were a single phenomenon common to all living things; and just as the older naturalists spoke of *species* in general as all fixed and comparable entities, so many of the present evolutionists speak of "varieties" in general as all comparable. This is a mere slurring of the facts. Not only must variability in respect of *different* characters be a manifestation of distinct physical processes, but, as we have seen, variability, even in what appears to us to be the same character, may be a wholly different matter.

Our business, then, is to test and examine these different kinds of variabilities according to their behaviour when the different varieties are crossed together. By this means we are enabled to investigate the properties of organisms in a way that no other method provides.

If I may be allowed to use a metaphor taken from chemical science, regarding species and varieties as substances, we may investigate their

properties and their powers of entering into genetic combinations, just as the chemist investigates the powers of his bodies to enter into chemical combinations.

To lump all the different manifestations of variation together as "varieties," and to rest there, is to give up in despair.

Similarly, it is certain that what we call "species" is a mixture of different phenomena, or rather of different classes of phenomena confounded under one name. I look to the study of cross-breeding to unravel that extraordinary mass of confusion. I look to this method of investigation to deliver us from the eternal debates on the subject of what is specific rank and what is not.

On the one hand we have at the present day many who devote themselves entirely to discussions of this nature, though they know in their hearts that their views correspond to no natural fact whatever. On the other hand, many in disgust and impatience reject the whole thing. "There is no such thing as species," say they. Both sides are surely wrong: there is such a thing as species, and we have to find out what are the properties of species.

It is true that, as to most species and varieties, artificial breeding is impossible, but in numerous cases a beginning can be made. Take merely the phenomenon of local varieties, or local species, or local races, about which such weary discussions have arisen. Each of these offers a particular example of the Evolution problem. In numbers of such cases an investigation of the behaviour on crossing could be practised, and very few such experiments would, I venture to predict, do more to establish true views of the relation of species and varieties than the labours of systematists will do in ages.

To come much nearer home, we do not know for certain the true relationships—in this special sense—between the varieties of the commonest domestic animals and plants. For example, I have been trying to investigate these relationships between the several kinds of comb in domestic poultry. I have thus far found no one who can tell me for certain what happens when they are crossed. The various forms of comb in our breeds of poultry—simple comb, pea-comb, rose-comb, &c.—are important structural features, which differ from each other very much as many natural species do. The answer generally given is that the result of such crossing is uncertain—that sometimes one result occurs, and sometimes another. This, of course, merely means that the problem must be studied on a scale sufficiently large to give a statistical result. There is here an almost untouched ground on which the properties of specific characters can be investigated. Many similar examples might be given.

True and precise experiments in these fields so ready to our hand have never been made. We appeal to those who have the opportunity to use it for the advancement of this fascinating line of research. It is delightful to form great collections of animals or plants, and to "bring out a novelty" may be an exhilarating sensation; but if anyone will abandon these well-worn pursuits, and devote himself to experimental cross-breeding, he will soon have his reward, for no line of research is likely to prove more fruitful.

FERTILISATION OF THE GENUS ANTHURIUM.

By Monsieur DE LA DEVANSAYE.

I HAVE published in the *Flore des Serres et des Jardins de l'Europe*, 1877, vol. xxii. p. 37, a general article on the fertilisation and hybridisation of Aroideæ. Some time after, in vol. xxiii. of the same journal, at p. 26, I also published an article in which I explained the evolution of Anthurium Scherzerianum. The two articles confirmed and illustrated the researches and results then obtained, and even the hopes of hybridists of those days.

I have also published in the *Revue Horticole* of Paris special articles dealing with the same subject. Those to whom these experiences are interesting, and perhaps of service, will find in the *Revue* the history of the genus Anthurium, as well as useful and necessary knowledge; but as I followed up and always continued my studies on Anthurium I think it my duty to draw attention, not only to the two rules which formerly were supposed to terminate the question, but also to a third one.

Rule 1. In most of the species of the genus Anthurium the fecundation only operates successfully when the pollen of the same species is taken from a plant raised from a different batch of seedlings.

Rule 2. The fecundation also operates with success by the application of pollen belonging to species of some allied genus; for instance, that of Spathiphyllum. This assures fecundation, and often gives variation to the colouring of the flowers, and at other times to the form of the flowers or foliage. When the variation shows itself in the flowers the growth of the plant is more vigorous. The contrary happens when it shows itself in the form and markings of the leaves. If the fecundation is only done with a view of reproducing and improving the type, the resultant seedlings coming from carefully selected varieties are generally more vigorous in point of growth.

Rule 3. Now let me form a third rule, resulting from the experiences of many years, and to which I think I ought to attract your most particular attention, as it does not seem to have been noticed or explained before.

I have already said how one can obtain variations, but in spite of good crossing it often happens that the first and second generations of seedlings have no (or very little) new blood in them. Such seedlings similar only to the type have been abandoned, given up, or destroyed. It is an error to do this because the variations may eventually result from a very slight—almost unnoticeable—change of the type. One must have patience, as the seed of the third and fourth future generations obtained from these plants may unexpectedly give the desired change.

It very seldom occurs that a variation is produced immediately among first seedlings of species or of hybrids; the process must be continued.

A second batch of seedlings will perhaps give 50 per cent., and a third trial 75 to 80 per cent.; thus half results may be obtained with the third generation, and from 75 to 80 per cent. with the fourth. These successive seedlings of the same variety are necessary to definitely insure the improvements obtained since the first generation. A careful selection must always be the principal aim of the raiser, because without that, far from succeeding in getting progress or improvement and fixing the definite success, the success itself degenerates and returns to the type.

DISCUSSION.

Mr. F. W. BURBIDGE, M.A., V.M.H.: I should like to ask Monsieur de la Devansaye whether he has ever obtained a hybrid between A. Andrianum and A. Scherzerianum.

Monsieur DE LA DEVANSAYE: Never; nor have I ever heard of one.

HYBRIDISING OF MONSTROSITIES.

By Professor Hugo de Vries,
University of Amsterdam.

The well-known hypothesis of Darwin with regard to the material transmitters of hereditary qualities, called Pangenesis, assumes that each particular quality is determined by a special transmitting body. This theory forms, in point of fact, though this is often overlooked, the scientific foundation of the speculations regarding heredity now so much in vogue. And in order to obtain starting points for experimental investigation in this branch of study, it is always best to return to the actual basis of the theory, since, as Mr. Galton says in his "Hereditary Genius," "it gives a key that unlocks every one of the hitherto unopened barriers to our comprehension of the nature of heredity." *

In connection with the teaching of Quetelet and Galton regarding the laws of continuous variability,† Pangenesis leads to the conviction that new distinctive features arise, not through this, but discontinuously. It is a question, it is true, of very small steps, but nevertheless they are steps, and not a gradual improvement of existing characters, as with the origination of races.‡

One very important result from Pangenesis appears to me to be that one and the same quality in various organisms depends upon the presence of the same material bearer.§

Such material unities may therefore be transferred from one species to another by means of hybridising. Thence must arise hybrids which would be just as stable as ordinary species, and which therefore, in certain cases, could imitate normal species.

If the literature of Hybridity be examined with regard to this question two facts present themselves. One is that a number of cases are mentioned which should be classed under this head; and the other, that very little is known of the way in which such a transferring of characters takes place.

In horticultural practice, especially, there have frequently been transferred with good results certain peculiarities in newly discovered or newly imported species into existing hybrid races. The genera *Gladiolus*, *Caladium*, and many others afford examples. In scientific trials also new and constant forms of mixed character have frequently been obtained by hybridising; as, for instance, by Lecoq with *Mirabilis*, and by Godron with *Datura* and *Linaria*. Focke, however, emphasises the unsatisfactory nature of our knowledge in this direction in his splendid work on "Pflanzenmischlinge" (p. 484). As is well known, stable hybrids are the result of the experiment; but of how it is done, how the transfer of the peculiarities is effected, we know as yet very little.

Professor Le Monnier, of Nancy, has recently observed a very remarkable case, and I am indebted to his kindness for the possibility of

* F. Galton, *Hereditary Genius*, p. 364.
† Bateson, *Materials for the Study of Variability*.
‡ "Unity and Variability," *The University Chronicle*, Berkeley, California, 1898.
§ *Intracellulare Pangenesis*, Jena, 1889

showing you the result. This is seen in two twisted stems of *Dipsacus fullonum*, which owe their twisting to a cross of the common Teazel with my hereditary race of *Dipsacus sylvestris torsus*.* As you will see, the twisting is just as perfectly developed as in the paternal form.†

In 1896, in the botanical garden at Nancy, there flowered both the plants in question, which had been cultivated for several years at a distance of about 100 metres from each other. Pollen could easily be transferred by insects. From the seed of *Dipsacus fullonum* plants were raised in 1897, among which three in the next summer had perfectly twisted stems. One of these bore an inflorescence with an involucre formed of bracts bent upwards; in the other two the bracts were bent outwards. It is well known that the first is peculiar to *D. sylvestris*, and the second form to *D. fullonum*.

It is to be remarked that in the same year the number of twisted individuals of *D. sylvestris torsus* was considerably reduced in Professor Le Monnier's garden. Professor Le Monnier was also kind enough to send me some of the seed of this hybrid: they were sown in April, and yielded vigorous plants, mostly of the *D. fullonum* type.

In this newest example of transferring a monstrosity by hybridising there is also, as regards the *modus operandi* of the transfer of the torsion character, very little known.

For some years, in connection with this position of matters, it has appeared to me that it would be interesting to investigate a single case of hybridising carefully and in full detail, and to describe the same. To this end I chose a very simple case, and one which could be followed thoroughly—viz. the transference of the lack of pubescence in *Lychnis vespertina glabra* into *Lychnis diurna*. The object was to produce artificially a hairless form of the latter.

This task is all the more important since the form in question has already arisen elsewhere in the ordinary way of variation. About 1842 Sekera had found the hairless form of *Lychnis diurna* on a mountain slope not far from Münchengrätz. It grew there in quantity, and has remained constant until now, that is, for more than fifty years.‡ He called it at first *L. diurna glaberrima*, but later *L. Preslii*. Under the latter name it is still found in botanical gardens, especially in Prague, in Tiflis, and in M. Correvon's garden at Geneva. From Prague Professor Celakowski sent me, in May of this year, a female plant, and later he sent me some examples collected for me by his assistant, Dr. Nemec, at the original station near Münchengrätz, for which aid my best thanks are due to both gentlemen.

I possess, therefore, now the material enabling me to compare my hybrids with these plants, obviously originated directly from *L. diurna*, and find that, as far as regards the leaves, stems, and flowers, there is no appreciable difference between the two.

Moreover I have addressed myself to Dr. Emil Sekera, Professor of Zoology at the K.K. Staatsrealschule in Jicin, in Bohemia, a nephew of

* "Monographie der Zwangsdrehungen," in *Pringsheim's Jahrbücher für Wiss. Bot.* vol. xxiii. Part 1, 1891.

† Two twisted stems of the new hybrid and several twisted stems of the paternal form were shown at the Conference.

‡ *Lotos*, iii. p. 133; *Oesterr. Bot. Wochenblatt*, 1854, p. 197.

the author of the species in question. He had the kindness to give me all necessary information. He also sent me an authentic specimen of the *Lychnis Preslii* collected by his uncle more than forty years ago. And now I have the pleasure of showing it to you for comparison.

Lychnis vespertina glabra, which formed the starting point of my trials, does not appear to have been so far described; at any rate, I have not found it named in the literature at my disposal.*

On the other hand, I found the plant itself at a station not far from Amsterdam, a station which has since disappeared. This was in August, 1888, in the vicinity of Hilversum, where I collected seed from fully dried and nearly unrecognisable plants. When the following year I sowed these in my experimental garden, there appeared a few hairless among many hairy examples. I collected the seed of the former and sowed them, and as the culture did not turn out to be a pure one, I isolated the hairless form later, during the flowering period. In 1892, in a bed containing many hundred examples, they were almost entirely true, since only a single more or less hairy plant was found.

As already stated, I then projected to transfer this hairless condition to *Lychnis diurna*, and in that way to produce artificially a *L. diurna glabra* or *glaberrima*.

The purpose of my experiments can also be thus described—viz. to obtain, in quite another way, the form known as *Lychnis Preslii*, which is recognised by many authors as a good species, and which apparently has arisen in the Bohemian Alps from *L. diurna*.

My attempt has fully succeeded. I effected the cross in the said year (1892),† and already in 1894 I had a not inconsiderable number of hairless examples of *Lychnis diurna*. The following year this form proved to be nearly constant, and since then I have cultivated it annually, and sometimes in large quantities. Among many hundreds of specimens there appeared only exceptionally solitary hairy individuals, so rarely, indeed, that this may perhaps be imputed to the introduction of weed seeds into the beds.‡

Hybrids between *Lychnis vespertina* and *L. diurna* have been obtained by Gaertner, Focke, and many other investigators.§ The crossing is easily effected; the hybrids are fertile, and even apparently no less fertile than the parent species (Focke). Godron has also crossed *Lychnis Preslii* with *L. vespertina*, and obtained hairy hybrids which did not essentially differ from those obtained by crossing *L. diurna* and *L. vespertina*. The investigation of the progeny of these hybrids does not appear to have excited much interest with the said authors. In the second generation these hybrids, as is the ordinary rule, break into various forms, among

* The pubescence in *Lychnis vespertina* and *L. diurna* is essentially the same. Long many-celled unbranched hairs form a soft covering, among which smaller glandular hairs are distributed.

† In order to protect my flowers from insect visits I cover them with parchment paper bags, which have for years proved excellent for the purpose. These bags can be got from the manufactory of P. J. Schmitz, in Düsseldorf. *Vide* a separate paper on the subject.

‡ "Erfelyke Monstrositeiten" in *Kruidkundig Jaarboek*, Dodonæa, 1897, pp. 71 and 87.

§ Gärtner, *Die Bastardbefruchtung im Pflanzenreich*, and Focke, *Die Pflanzen mischlinge.*

which, besides the hybrid type, the paternal and maternal characters appear more or less sharply defined. For my purpose, however, it was specially desirable to observe the behaviour of the subsequent generations.

When in 1892 I wished to effect the first cross, I sowed to that end seed of *Lychnis diurna* obtained by exchange in the usual way from botanical gardens. The seed-bed, about one metre square, yielded a brightly coloured mixture of various forms. Certainly all the plants were normally pubescent, but between *L. diurna* and individuals similar to *L. vespertina* there were almost all grades and combinations, both as regards habit of growth, form of leaf, and colour of flower, as well as the formation of flower stalks in the first year, or only leafy rosettes.

During the flowering I selected three female plants, which appeared to me to present the pure characteristics of *L. diurna*. They had the normal pubescence and dark-red flowers. All the rest were weeded out, and from these three examples the flowers, which were already open or had faded, were removed.

I then fertilised these three plants with pollen from my *Lychnis vespertina glabra*, and they yielded plenty of seed.

The following year I sowed from this seed a bed of about two square metres, and had at the flowering period something over 200 examples. I sowed some more also in the greenhouse, for control and pot culture.

This first generation of hybrids, up to the time of flowering, appeared very uniform. All the plants were hairy and had the characters of *Lychnis diurna*. Closer examination, however, during the flowering period, afforded opportunity for some not unimportant observations.

In his excellent work upon "The Minute Structure of Plant Hybrids," Mr. Macfarlane has carefully examined how hybrids are constituted with regard to anatomical characters which are absent in one of the parents but present in the other.* He treats of these cases together under the name of Unisexual Heredity, and deduces the rule that they "are handed down, though reduced by half." *Lychnis vespertina* and *L. diurna* have both, upon all parts of the plant, long, soft, many-celled, sharply pointed hairs, among which there are scattered glandular hairs, rare upon the stems and more numerous upon the flowers. The hybrid between *L. diurna* and the hairless form of *L. vespertina* has shorter and blunt-ended hairs and a lesser number of glandular hairs, especially on the stalks.

Of my hybrids, in the first year about two-thirds produced flower stalks, whilst the remainder only formed rosettes of basal leaves. It is well known that *L. diurna* is a perennial species, whilst *L. vespertina* is an annual or biennial. But then *L. diurna* also frequently flowers the first year, as did the mother plants, which germinated and flowered in 1892, when they served for my crossing experiment.

I have especially directed my attention to malformations. It is said, and pretty generally acknowledged, that hybrids show a greater tendency towards malformations than do the parental forms. In my seed-beds they were not rare. In the first place, as regards the number of the pistils, Gaertner (*l.c.* pp. 342 and 531) found in *L. diurna* × *vespertina* occasion-

* J. Muirhead Macfarlane, "The Minute Structure of Plant Hybrids," *Trans. Roy. Soc. Edin.* vol. xxxvii. Part 1, No. 14, 1892, p. 273.

ally six, and regards this as an example of increase of the female organs by hybridisation. I found upon my hybrids a fair number of flowers with six, and a few with seven pistils. I thereupon examined my stock plants of *Lychnis vespertina glabra* and found the same deviation among them. I had therefore simply overlooked it the previous year, and it is not to be doubted that, in this case at least, the malformation has not resulted from the crossing, but is simply inherited from one of the two parents.

It results, however, from this that the same explanation may be true in other cases: the hybrids are, as a rule, examined more closely than their parents, and hence more malformations are remarked in them.*

I found furthermore, in my bed of hybrids, tricotyledonous and hemitricotyledonous plants, divided leaves, triple leaves, fasciate stalks and forked ones, four-petalled flowers ($K_4C_4M_8$), and other malformations. Most of these divergences, however, I found on careful examination to exist on one or both of the parental species. They were, therefore, simply inherited.

The inheritance of malformations by hybrids I have often found confirmed by experiments with species of other genera: it appears to me to form a rule which so far has been too much overlooked as an explanation of hybrid characters.

The colour of the flowers in my culture bed varied greatly. The great majority were purple, some were quite white, others dark red, but, as it appeared to me, not so deeply red as the mother plants in 1892. Between these three principal colours there were numerous grades of intermediate tints.

Gaertner also (*l.c.* p. 241) found the colour of the flowers of his hybrids to vary: by far the greater number were purple; a few, however, were white-flowered.

It appears to me to be very unlikely that the cause of this variability is to be found in the crossing. I would rather assume as an explanation that the examples fertilised by me in 1892 in this connection were not of pure origin. They were selected from a varied mixture of colours as the finest examples. Regarding their integrity, I had at the time when I fertilised them no cause for doubting it. If they, however, were hybrids between the various forms of the mixed lot in question, one would naturally expect white-flowered offspring as well as red to be yielded by the seed.

On this view the circumstance, that my hybrids of the first generation were variable as regards the colour of the flowers, justifies the supposition that they have simply inherited this variability from their mothers. And this assumption may possibly embrace the essence of an explanation of the variability of so many hybrids in their first generations, since only in the rarest cases have the parental forms, in hybridising experiments, been carefully tested as to their constancy. It does not suffice that they appear to be of a constant type. Many hybrids are exteriorly hardly to be distinguished from one or other of the parents, and therefore many hybrids may easily be mistaken for true species. In many other

* It has been so in other cases. When I began to give special attention thereto I found twistings and ascidia to be much more frequent than one would expect from existing literature. Compare for the first *Ber. d. d. bot. Ges.* vol. xii. 1894, p. 25; and for the latter, *Dodonæa*, 1895, vol. vii. p. 129, *Over de erfelijkheid van Synfisen.*

experiments I have subsequently been able to test my hybridising material in this respect, and found the assumption above given to be confirmed; unfortunately, in this case it was no longer possible.

In the horticultural practice of hybridising it is a rule to choose forms of which one at least is very variable, and hence arises the known multiformity of the hybrids.

With regard to the flowers and other important characters, my hybrids resembled the true *Lychnis diurna.*

I come now to the third generation, which I cultivated in 1894. For this I used seed of the dark-red examples of 1893, which I had fertilised with pollen from equally dark-coloured flowers, taking care to exclude insect visits.

But whilst in 1893 all the hybrids had been hairy, this was no longer the case in 1894. Only about three-fourths were hairy, the rest hairless. I had 99 hairy and 54 hairless, in all 153 plants, and counted them in July at the commencement of flowering. The character of the grandfather, the transfer of which I had had in view, was therefore once again visible.

Both among the hairy and among the hairless plants there were red-flowered and white-flowered and broad-leaved and narrow-leaved examples; the broad-leaved had the habit of *L. diurna,* the narrow-leaved that of *L. vespertina.* Also, as regards the corolla and the calyx, there was a similar diversity of form. The parental characters were, in all imaginable combinations and grades, to be found in the bed of seedlings.

As confirmation of the above, as regards the inheritance of malformations, I found, for instance, a flower with two corollas in one calyx.

Among the vari-coloured mixture, I now sought out my *Lychnis diurna glabra,* selecting some male and female examples, which latter I fertilised with the former, excluding insect visits. They were entirely hairless broad-leaved plants with the flowers of *L. diurna* and with dark-red petals—characteristics of the grandfather, with the exception of the entire hairlessness, I failed to find.

The seed reproduced the desired form in the following year (1895) quite truly—at least as regards the absence of hairs and the other constant characteristics of my starting plants. Only the colour of the flowers remained variable. Out of 206 plants there were 13 white-flowered, or about 6 per cent. The rest were partly purple, partly dark red.

As regards the pubescence, I have made the following experiments. As the bed was in the vicinity of that in which the culture of the previous year had been made, its integrity, owing to possible subsequent germination of older seed, was not certain. I sowed, therefore, a portion of seed in pans with sterilised soil and raised 390 young plants, all of which were hairless. The transmitted character could therefore be regarded as constant.

In the two following years (1896 and 1897) I have carried the new form through two further generations, choosing always the dark-red individuals as pollen and seed parents. In 1897 I had a bed of four square metres, containing about 1,350 plants. Pubescent plants occurred

in both years as solitary specimens, perhaps through chance introduction of seed. On the other hand, I did not succeed in reducing the number of white-flowering plants to any marked extent: it remained about 6 per cent.

If the white-flowering plants be isolated, it is found that they are fully constant. I fertilised them in 1893 in the first hybrid generation, when they were all hairy. The hairiness was inherited, as in the red-flowered plants, in three-fourths of the individuals, but the white colour in nearly every individual. I fertilised the hairless white-flowered plants with pollen from same type, and could now, according to the experience given above, rely upon having the seed of an almost completely true and sufficiently constant new form, *Lychnis diurna glabra alba.*

It is to be remarked that Sekera mentioned that his *Lychnis Preslii* produced no white-flowered examples.

As regards monstrosities, it appeared that split leaves and twisting were inherited in this race.

To summarise the progress of our experiments, it may be stated that the fertilisation of *Lychnis diurna* by *L. vespertina glabra* succeeded easily. The hybrids of the first generation were, with the exception of the colour of the flowers, alike; they were all hairy, only in a less degree than the mother plants, but otherwise very like it. In the second generation they broke into the most varied combinations and mixtures, among which hairless plants of the *Lychnis diurna* type were easily found, both red-flowered and white-flowered. These proved themselves both fully constant from the very moment of their first appearance, especially in regard to their smoothness, and remained so during all the succeeding generations. Only the red-flowered seed always yielded about 6 per cent. of white-flowered plants.

The artificial production of *Lychnis diurna glabra*, which, with the exception of constancy of the flower colour, seems to be identical with *L. Preslii* of Sekera, may therefore be regarded as entirely performed in the course of nearly four years.

HYBRIDISATION AND ITS FAILURES.

By the Rev. Professor G. HENSLOW, M.A., F.L.S., V.M.H., &c.

INTRODUCTION; DEFINITION OF A SPECIES.—In endeavouring to find some clue to the interpretation of hybrids, as to why some species when crossed fail, while others succeed and bear fertile offspring, it is desirable to consider what is the present idea of a species. Two considerations were formerly maintained, viz. morphological structures and a presumable physiological affinity. Thus Bentham defined a species as follows: "A species comprises all the individual plants which resemble each other sufficiently to make us conclude that they are all, or *may have been* all, descended from a common parent." *

This definition may be sufficient as long as no physiological question is raised as to the capabilities of different species of the same genus intercrossing. Dean Herbert, however, soon found that another element must be considered, and that was interbreeding. Since the practice of hybridising plants has been extensively pursued ever since he wrote, the idea has been maintained that if two species would cross and produce fertile offspring, then they must be regarded as of common parentage, and as being only varieties of one and the same species. Thus Dean Herbert writes, referring to experiments of Knight: "The President adopted in his writings a principle or dogma, which seemed to be then much relied upon by botanists, that the production of a fertile cross was proof direct that the two parents were of the same species, and he assumed as a consequence that a sterile offspring was nearly conclusive evidence that they were of different species." He then further adds: "I held also . . . that the production of any intermixture amongst vegetables, whether fertile or not, gave reason to suspect that the parents were descended from one common stock and showed that they were referable to one genus; but that there was no substantial and natural difference between what botanists had called species and what they had termed varieties. . . . If two species are to be united in a scientific arrangement on account of a fertile issue, the botanist must give up his specific distinctions generally and entrench himself within the genera." † Testing the question as to the more or less agreement in external features between so-called closely allied species being correlated with fertility in their hybrids, we now know that the general rule may be formulated that such is the case; yet there are so many exceptions that the suggestion of Herbert for systematists to follow must be disregarded, and that they must continue to describe new species and genera solely by the morphological characters they present.

This is practically what is always done; so that for purely systematic purposes it would seem that physiological affinity must be neglected altogether, as, *e.g.*, when masses of dried plants are sent to Kew from some newly explored country.

* Introduction to the *Handbook of the British Flora*, 1865, p. xxxvii.
† *Amaryllidaceæ*, p. 336.

What then is a definition of a species? The following may perhaps answer the question. A species is known by a *collection* of, presumably, relatively *constant* characters; which may be taken from any or all parts of the plant. But *how many features* are required to distinguish a species from a sub-species or variety is a matter of opinion, and will always remain debatable. Indeed, the difference between an "artificial" and "natural" system of classification depends greatly on this point: for any group in the former is based on one, two, or very few points of agreement; in the latter it is generally on as many as possible. Though, in many cases, a single character *may* coincide with the strictest affinity, such as the tetradynamous stamens of the *Cruciferæ*, the papilionaceous corolla of a great section of *Leguminosæ*, &c.; and when we come to other large groups with irregular corollas, we find that systematists professing to classify plants on a natural system do not hesitate to drop into an artificial one when it suits their purpose. For example, *Liliaceæ* are separated from *Amaryllidaceæ* solely by having a superior ovary. Yet elsewhere we can find both inferior and superior ovaries in genera of the same order, as in *Samolus* and *Primula* of *Primulaceæ*; or, again, in species of the same genus, as *Saxifraga tridactylites*, *S. umbrosa*, and half-superior in *S. granulata.*

But although the two orders mentioned above are separated on account of this single character alone; yet, testing it by crossing, no known attempt to unite two members of these orders has ever yet succeeded, as far as I can hear from experimenters. It would seem, therefore, that they have been differentiated at so remote a period that they have lost all physiological connection.

So too with genera; the corolla of Snapdragon only differs from Toadflax in having a small pouch at the base, which elongates into a spur in the latter. I can hear of no cross raised between them. Now *Rhododendron*, *Rhodora*, and *Azalea* are as much entitled to be called genera respectively, if systematists may separate genera by such slight differences as the above; and there is no reason why they should be merged into one, *solely* because they will interbreed: for if interbreeding is to be a test, then those polymorphic forms of one and the same species that *cannot* be intercrossed with complete fertility ought to be separated, as of *Lythrum*; to say nothing of *Linum perenne* and some Orchids which cannot bear seed with their own pollen.

Rhododendron jasminiflorum has a corolla as unlike that of a typical Rhododendron as can well be imagined—indeed, Mr. Burbidge likens it to *Erica Aitonii*—and might be regarded, therefore, with justice as a different genus; since systematists separate the genera of plants with irregular corollas entirely by that organ in many cases—as in the *Scrophularineæ.* Now it will cross readily with *R. Javanicum*, which has the typically formed corolla; but not with the American, or species of other countries. On the other hand, Mr. Burbidge crossed *R. jasminiflorum* with an Indian Azalea as the male parent.

Let us take as another instance, the "genera" *Lælia* and *Cattleya.* Species of these two have yielded many so-called "bi-geners"; but are they worthy of the name? Now the variations in the forms of the flowers of different species of *each* of these two genera do not differ more

among themselves than between different species of these genera. In other words, they would form one genus if the perianth alone were the basis of classification. But this is not the feature relied upon, but the *number of pollen masses*—*i.e.* a single feature, and therefore, so far, an *artificial* character—just as Linnæus would unite the Ash tree, Veronica, a Grass, and the Duckweed *because* they have two stamens. Turning to the "Genera Plantarum" we find that *Cattleya* has four pollinia. Then follow three genera with eight in two series; those of the upper series very often much smaller than the lower. Then comes *Lælia*, also with eight pollinia in slightly unequal series.*

Here, then, is obviously a closely graduated series based on a single character, and a purely artificial one. The classification is therefore not strictly natural, though the series of so-called "genera" may be. Consequently, though we may call the cross-products "bi-geners," it is only so from Bentham and Hooker's classificatory point of view.

These observations apply to *Epidendrum* and *Sophronitis* as well.

Similarly with the so-called bi-gener between *Lapageria* and *Philesia*. Those genera stand together in the "Gen. Pl.," being No. 10 and No. 11 in *Liliaceæ*: both are mono-specific, and both live in Chili. The distinguishing features are recorded as being, in *Lapageria*, "Leaves 3–5-nerved," and "the segments of the perianth sub-equal." In *Philesia*, "Leaves 1-nerved," and "the exterior segments of the perianth are much shorter than the interior." But much greater differences in nervature occur in species of *Plantago*; and also between the outer and inner whorls of the perianth of species of Iris.

Consequently, to be true to principles of natural classification, it would seem that the above two genera should be regarded simply as two species of the same genus.

Once more, in the "Gen. Pl." *Gloxinia* (gen. 6) and *Achimenes* (gen. 7) belong to the sub-tribe *Gloxineæ*; while the genera *Gesnera* (gen. 18) and *Sinningia* (gen. 19) are in the sub-tribe *Eugesnereæ*. There is, however, no special feature to separate them—a fact which Dean Herbert perceived and discussed at length some seventy years ago.†

He mentions also that *Sinningia* and *Gloxinia* produced fertile hybrids.

Gloxinera—i.e. *Gloxinia* × *Gesnera*—was raised in 1894.‡

Selenipedium and *Cypripedium* are genera which Bentham and Hooker admit to be scarcely distinguishable except by the ovary being one-celled in the former, from a want of cohesion of the placentas, and its habitat, viz. South America, the nearest home of the latter being Mexico.

Though it has been found difficult to cross these, yet Mr. Swinburne, of Winchcombe, near Cheltenham,§ raised small plants from *S. Schlinii* × *C. Spicerianum*, male parent; also between *S. Dominianum* × *C. Chamberlaini*. The plants were raised in 1896, but have not yet flowered.

* See observations by Mr. C. C. Hurst relative to this matter, *Journ. R.H.S.* 1898, p. 475.

† *On Hybridisation amongst Vegetables.*

‡ For successful Bi-geners and Hybrids in *Gesneriaceæ*, see Burbidge's *Prop. and Improv. of Cul^r. Plants*, p. 331 seqq.

§ *Gard. Chron.* Oct. 10, 1896, p. 435.

BI-GENERIC FAILURES.—If species of the same genus, but natives of widely distinct countries, often refuse to cross; *à fortiori*, would it be anticipated that genera of the same order would fail? The genus *Hippeastrum* has been used for attempted crosses with other genera from warm countries, of the order *Amaryllidaceæ*. Thus, it has failed with *Sprekelia*, the former being of tropical and South America; the latter—a monotypic form—of Mexico.

Hippeastrum has failed to produce healthy progeny with Clivias of South Africa. Mr. Wright observes: "This attempted cross was successful so far as the actual cross went; but the progeny were so weak that the seedlings only lived about a year. This proved to be the case with three distinct lots of seeds."

M. Rodigas, of Ghent, makes a suggestive observation: "The decay in the persistent leaves of many plants of *Clivia* may be attributable to the employment of pollen from *Amaryllis* and *Hippeastrum*, the leaves of which are deciduous." *

Hippeastrum has also failed with *Vallota* and *Hæmanthus*, both of South Africa. Attempts have been made to unite *Hippeastrum* with *Urceolina* (Andes) and *Pancratium* (Mediterranean regions) without success; but as these genera belong to a different sub-tribe, as well as widely different countries, the probability of their having any physiological or constitutional affinity was proportionally diminished. Similarly, attempts to cross *Griffinia*, allied to *Hippeastrum*, with *Eucharis* and *Urceolaria* failed.

Of other genera of the *Amaryllidaceæ* of widely different countries that have failed are *Amaryllis Belladonna* (South Africa) with *Lycoris* (Japan, China, &c.).

Of two genera of the same sub-tribe—*Cyathiferæ*—*Pancratium canariense* failed with *Eucharis grandiflora* (Andes).

But genera from the same country may fail, as *Cyrtanthus* with *Vallota*, genera closely allied and both of South Africa. Similarly, *Zephyranthes brachyandrum* has failed to cross with *Hippeastrum stylosum*, *H. sub-barbatum*, *H. equestre*, and *H. vittatum*, though these two genera are very closely allied; but while *Zephyranthes* are natives of tropical and sub-tropical America, *Hippeastrum* belongs to South America.

Crinum and *Amaryllis* (gen. Nos. 26 and 27 in "Gen. Pl.") have failed to cross as far as the following species are concerned: *C. Moorei*, *C. fimbriatulum*, and *C. zeylanicum*. †

A large number of bi-geners have been attempted at the Utrecht Botanic Gardens, but without results. The following is a selection: Helleborus × Caltha, Caltha × Eranthis, Caltha × Nymphæa, Caltha × Pæonia, Fuchsia × Œnothera, Bellis × Cineraria, Hemerocallis × Lilium, Pancraticum × Crinum, Phalænopsis × Vanda, &c.

Of other genera in which the morphological characteristics would warrant an *à priori* probability of success in crossing, but failed on practice, is *Streptocarpus* × *Didymocarpus*; but while the former genus

* *Gard. Chron.* Jan. 5, 1895, p. 16.

† Other failures among genera of AMARYLLIDACEÆ are *Elisena longipetala* × *Hymenocallis calathina*; of IRIDEÆ, *Cypella plumbea* × *Herbertia pulchella*, *Iris Robinsoniana* × *Marica cærulea*; of AROIDEÆ, *Alocasia* × *Caladium*.

is found in South Africa and Madagascar, species of the latter are natives of the Malay Archipelago, and E. Asia; so that in this case constitutional affinity does not correspond with morphological resemblances.

That *Streptocarpus* should fail to be crossed by *Gesnera* was more likely, as, besides being natives of different hemispheres, they are distantly located in the "Genera Plantarum."

Of sub-genera that failed to cross, *Mimulus* × *Diplacus* may be mentioned.

Though *Epidendrum radicans* has been successfully crossed as male with *Sophronitis grandiflora* female, yet *S. violacea* has been crossed with *E. radicans* and *E. Obrienianum* without result.

Constitutional Affinity and Sterility.—Admitting the fact that the closer agreement there may be between the forms of two species, the more likely is it that they will cross, yet it is not universally true; so that, leaving "morphological affinity" out of the question, we have to depend on, for want of a better expression, what one may call "constitutional affinity," cautioning the reader that this is a phrase which covers our profound ignorance of the true nature of physiological affinity!

Dean Herbert observes: "Some crosses are sterile and some quite fertile, without any apparent reason, except the greater or less approximation of constitution in the parents; and that the cross-bred plant which has seemed for a long course of years to be absolutely sterile becomes under some circumstances productive." *

The last sentence is important, for it introduces another fact, that sterility and fertility are not absolute features, but vary in the same plant according to circumstances; and it applies to self-fertilisation as well as crosses and hybrids. Thus, Darwin found that the dimorphic forms of *Linum perenne* were self-sterile; but Mr. T. Meehan, of Germantown, Philadelphia, had *one* form only in his garden, which never set seed for fourteen years; yet, then, one branch bore flowers which became homomorphic and immediately fruited. Under cultivation Primulas of various kinds, as *P. sinensis*, can become self-fertile in a similar way.† *Eschscholtzia californica* was self-sterile in Brazil, but acquired great self-fertility in England in three years—nearly 87 per cent. ‡

Dean Herbert says elsewhere: "Experiments have confirmed the view to such a degree as to make it almost certain that the fertilisation of the hybrid or mixed offspring depends more upon the constitution than the closer botanical affinity of the parents." §

He illustrates this by the genus *Crinum*, showing that while certain nearly—*i.e.* morphologically—allied forms are difficult to produce fertile hybrids, others so distinct as to have been placed in different genera do so, the interpretation being that the latter were aquatic plants, and therefore presumably of the same constitution; whereas in the former case the ineffectual cross was made between an aquatic and a terrestrial form frequenting dry localities.

This hybrid between *C. capense* (aquatic) and *C. scabrum* continued for sixteen years to be sterile, but "produced one good seed in 1834, and

* *Amaryllidaceæ*, p. 340.
† *Origin of Floral Structures*, p. 209.
‡ *Ibid.* p. 320.
§ *Amaryllidaceæ*, p. 342.

again in 1835." He mentions another instance of a sterile hybrid, called *C. submersum*, growing near Rio Janeiro in company with a small variety of *C. erubescens*. It was exactly intermediate between this species, which is aquatic, and *C. scabrum* of high ground.

Of dissimilar species readily crossing, Dean Herbert * alludes to "the prickly, angular *Cereus speciosissimus*, the flexible *C. flagelliformis* or Whip-plant, and the unarmed *C. phyllanthocides*, are nearly the most dissimilar; yet they have produced mixed offspring, which readily bears edible fruit of intermediate appearance and flavour."

As illustrations of failures through constitutional differences, Mr. Buffham could obtain no success between perennial and annual species of Sunflower. With Rhododendrons, Mr. Veitch could get no hybrids between the East Indian hybrids and the Himalayan section, nor with the *R. arboreum* section.

With Primroses, all British species fail to cross with *Primula sinensis* either way; and a significant fact is that all kinds of cultivated *P. sinensis* fail now to cross satisfactorily with the original wild form, according to Mr. Sutton's experience; for though he was successful in obtaining ten plants from two crosses between *P. sinensis* "Chiswick Red," the female, and the original *P. sinensis* as male parent, all ten plants were very weak, and all died while in the first stage of flowering. Messrs. Sutton, however, have never been able to obtain any seed from the original *P. sinensis* when pollinated by any other variety. It is self-fertile. *P. sin.* "Stellata," apparently the same as "The Lady," and representing an early stage of cultivation, can cross (either way) with the normal cultivated forms.

P. obconica failed to be crossed with *P. sinensis* by Messrs. Sutton; but with Mr. Wright, of Chiswick, it so far succeeded that while the progeny resembled the mother; that of the second generation indicated the effect by bearing flowers with four, five, six, or seven petals, and once eight; no such disorganisation occurred in the first generation.

It would therefore seem to be a common, if not a general, rule that species of different countries present greater difficulties in crossing than those of the same country, which probably grow under similar conditions. Thus, *Fuchsia procumbens* of New Zealand refuses to unite with the South American species, which readily intercross. Mr. W. G. Smith tells me that the outline of the pollen-grains of the former species is spindle-shaped, while of the latter it is a spherical triangle.

Indian Azaleas are difficult to unite with the deciduous species of Japan.

Begonia "semperflorens" section will not be successfully crossed with the tuberous section.

Begonia ricinifolia × *B. tuberosa* (hyb.) produced seeds but no plants at the Utrecht Botanic Gardens.

As instances of failures between species with marked morphological differences, yet residing in the same country, may be mentioned the "Fancy" Pelargonium with the scarlets. Krelage failed also in attempting *Pelargonium gibbosum* with *P. zonale*. Other failures between species crossed by this experimenter were *Aristolochia elegans* × *A. bra-*

* *Amaryllidaceæ*, pp. 343 and 345.

ziliensis; *Stanhopea eburna* × *S. tigrina*, which bore fruit, but it decayed before ripening.

With regard to Cypripediums, Mr. Veitch sends the following observations as the result of his experience. No progeny has yet been raised from crossing the species of *Selenipedium* with *Cypripedium* (Sect. *Coriaceæ*, Benth., *Paphiopedium*, Pfitzer), or *vice versâ*, or between species of either of these sections and the hardy *cypripedia* (*foliosæ*, Benth.).

The species chiefly used in the experiments were, of *Selen.*, well-nigh all in cultivation; of *Cyp.* (*coriaceæ*), the group of species known among horticulturists as the *barbatum* section, distinguished by their one-, rarely two-, flowered scapes, their tessellated foliage, and their semilunar staminode; and the group called the *Stonei* section, distinguished by their many-flowered scapes, their pendent, narrow petals and shield-shaped staminode; and in *Cypripedium* (*foliosæ*), our native species. *C. Calceolus*, and the American species *C. spectabile*, *C. pubescens*, &c., have formed capsules in abundance, but they were invariably barren.

Interesting experiments upon the capability of pollen have been made by Professor E. Strasburger, which show that very similar effects of imperfect fertilisation can be produced where it cannot be said that there is any affinity at all. Thus, he found that *Lathyrus montanus* would put out pollen-tubes, which will enter the ovary of *Convallaria latifolia*; those of *Agapanthus umbellatus* will penetrate deep into the style of *Achimenes grandiflora*. Those of *Fritillaria persica* will not only enter the ovary of species of *Orchis*, but will even excite the development of the ovules and will cause them to begin to swell. The pollen-grains of *Achimenes grandiflora* will not, on the other hand, penetrate the stigma of *Agapanthus*.

The possibility of the pollen-grains of one species or genus developing tubes on the stigma of another species or genus does not depend upon the possibility of hybridisation between them. *As a rule*, the pollen-tubes penetrate the style or ovary to a depth proportional to the relationship of the species; though *Lathyrus montanus* and *Convallaria*, as mentioned above, are exceptions.

That varieties of the same species exhibit greater capacity for exciting the development of pollen-tubes than species of the same genus, depends simply on a greater resemblance in the composition of the nutrient material, furnished to the pollen grains and tubes by the stigma and style.

Hybridisation is an evidence of sexual affinity, but its non-occurrence is no evidence of the absence of affinity.

Excessive Prepotency, or False Hybrids.—The question as to the influence of the male or female parent respectively has often engaged the attention of hybridisers. In some features one parent has seemed to predominate, in others the other parent; while perhaps as a general rule neither does so, but the progeny are strictly intermediate between them.

Experience, however, leads one to the conclusion that, starting from the intermediate condition, either parent may predominate in every degree, up to an apparently exact imitation of itself in the hybrid offspring. In

other words, its influence has been so prepotent as to arrest all trace of the other parent in the offspring.

M. Millardet, who studied the hybrids between Alpine and American Strawberries, called these extreme results "False Hybrids." *

This peculiarity was early observed, for Gaertner records the fact that *Datura Stramonium* × *D. ceratocaulis* bore two fertile plants which resembled the female except in height. Their seeds produced *D. Str.* normal.

D. Lævis × *D. Str.* bore forty plants resembling the male parent. Mr. Burbage records somewhat similar results as obtained by Mr. Anderson-Henry with Veronicas,† observing on a particular instance: "I have seldom seen two hybrids with so much of one parent and so little of the other." Mr. T. Meehan, of Germantown, Philadelphia, has experienced the same thing; for example, he says that "*Disemma aurantia* × *Passiflora cœrulea* as the male parent, gave rise to a progeny which was simply *Disemma*,‡ with no trace of the Passion-flower." Again, *Fuchsia arborescens* × garden hybrids "bore seedlings which, both in foliage and flowers, were *F. arb.*, and nothing more." Lastly, *Quercus palustris* × *Q. imbricaria* resembles the female parent entirely, except that it has numerous *entire* leaves as well, which are like those of *Q. imb.*, but in venation and all other characters it is wholly *Q. palustris*.

In speaking of *Fuchsia longiflora* × *F. fulgens*, Mr. Meehan observes that "several dozen plants were raised, all being from one berry; but no two of the many seedlings were alike. Some nearly approached the female, others the male parent. *None* could fairly be said to be intermediate."

Herr Max. Leichtlin found from his experiments that "the female parent gives to the offspring *form* and *shape* of the flowers; while the male parent gives more or less the colouring of the flowers; and if it is richer and *freer-flowering* than the female, this property is transferred to the offspring." To whatever degree it may be true for certain plants, no absolute law appears capable of being formulated. Thus, Dr. Denny remarks on *Pelargonia*: "The result of my experience, derived from experiments as regard the relative influence of the parents, certainly tends in the reverse direction to my previous ideas, which were derived from books, from which I gleaned that the form of the flower and constitution and habit of the plant were inherited from its mother; while the colour of the flower only was supposed to be conveyed by the father. The recorded results of my crossings indicate an immense preponderance of influence over the progeny on the part of the father in all respects—in colour and in form, in the quality, in size and substance of the flower, as well as in the production of variegation of the foliage, and in the habit and constitution of the plant also, provided the plants employed were of equal strength."

Dr. Denny "fertilised without much difficulty a variety (*Peltatum elegans*) of the Ivy-leaved section by the pollen of the zonal. . . . The

* *Hybridation sans croisement, ou Fausse Hybridation* (1894). See *Gard. Chron.* 1894, Nov. 10, p. 568.

† *Op. cit.* p. 537.

‡ A section of *Passiflora* (*Gen. Pl.* vol. i. p. 811).

foliage [of the cross] resembled almost entirely that of the mother; which is the reverse of my experience of the results produced between varieties." *

Mr. C. C. Hurst experienced the same thing in Orchids. Thus he writes: "In May, 1891, Mr. R. Young, of Sefton Park, Liverpool, crossed *Cypripedium barbatum* with pollen of *C. niveum*. Fourteen hybrids were raised. . . . Every one of nine which flowered was *C. barbatum*, without a trace of the father parent, *C. niveum*." †

Mr. James Douglas has also shown how the same phenomenon occurs in the case of Carnations.‡

Mr. Moore, of the Royal Botanic Gardens, Glasnevin, informs me that he has never succeeded in crossing *Lachenalia pendula* with any other species or variety. On one occasion he thought he had succeeded in doing so with *L. aurea*, but the seedlings were only *aurea*. He also failed to raise a hybrid between *Helleborus niger* and any other species. When crossed with *H. orientalis* the progeny proved to be *H. niger*.

Non-reciprocity in Hybrids.—As a general rule, it may be stated that hybrids are not only intermediate in character between their parents, but that they are alike when either parent is the male or female. But it is not always so; and the peculiar difference may occur of a species being readily crossed with others, yet refusing to cross them in return, or *vice versâ*. Thus Mr. J. Scott says: "I inserted pollinia of *Oncidium microchilum* into the stigmatic chamber of eight flowers of *O. ornithorhyncum*; of these, three produced capsules containing about 21 per cent. of good seed. I also tried the converse experiment, and applied pollinia from *O. ornithorhyncum* to the stigmatic chambers of twelve flowers of *O. microchilum*, but in this case I failed in causing a single capsule to swell." §

Mr. Burbidge || records a similar fact of *Rhododendron Edgworthii* as narrated by Mr. J. Anderson-Henry, who writes: "While it has been repeatedly made the male, it has never submitted to become the female parent. . . . *R. Nuttalli* behaved in the same manner." He further adds: "This remarkable circumstance of non-reciprocity has perplexed and defied me in innumerable instances throughout my long experience in these pursuits."

Mr. E. Scaplehorn, of Mayford, Woking, writes me with regard to *Clematis coccinea*: "I understand, from experiments made here respecting the new *C. coccinea* hybrids, that *C. coccinea* when used as the female parent did not produce any material results; but only when the various varieties of *C. Jackmanni* were crossed with the pollen from *C. coccinea*, was the production of these hybrids possible."

Again, *Mirabilis longiflora* × *M. Jalapa* proved a failure, though the reciprocal hybrid was a success.

Professor F. Parkman records his experience of a like kind with Lilies.¶

* "On the Relative Influence of Parentage," *Journ. R.H.S.* New Series, vol. iv. pp. 18, 19, and 23.

† "Notes on Some Curiosities of Orchid Breeding," *Journ. R.H.S.* 1898, p. 442.

‡ "Cross-fertilisation of Florists' Flowers," *Journ. R.H.S.* 1897, p. 205.

§ *Journ. Lin. Soc.* xv. p. 164, where other instances are mentioned.

|| *Op. cit.* p. 299.

¶ *Gard. Chron.* Jan. 5, 1878, p. 19.

Oncidium Papilio × *Phalænopsis grandiflora* was crossed, but failed at the Utrecht University Botanic Gardens; but the reverse cross has succeeded, the seeds of which have been saved and sown, but the result is at present unknown.*

Non-reciprocity also occurred in *Epidendrum*. Thus Mr. Veitch found that *E. radicans* could be successfully used as the male parent with *E. evectum*, *Cattleya Bowringiana*, *Lælia purpurata*, and *Sophronitis grandiflora*; but when itself has been used as the seed-bearer the cross invariably failed. Trials have been made with the pollen of its own progeny, as *Epiphronitis Veitchii* (=*E. radicans*, male; *Sophronitis grandiflora*, female), and of *E. Obrienianum* (*E. radicans*, male; *E. evectum*, female), but with no better result. Yet when pollinated with its own pollen it seeds freely.†

INFERTILE "CROSSES" BETWEEN VARIETIES.—As different species of one and the same genus may or may not yield successful hybrids—thus, while the "Fancy" Pelargonia and the zonals mostly breed together, respectively, yet these two sections will not unite—so, too, is it the case with varieties. Mr. C. E. Pearson writes me on crossing Pelargonium vars.: "The French seem to have differentiated three strains of zonal Pelargoniums, two of which are quite sterile with our own. The first failure was with a variety called, I think, Dame Blanche (some twenty years ago), which refused to cross, either as male or female, with our English varieties, but was fertile with its French contemporaries. The second was with the 'Bruant' race of zonals, a strain with huge trusses, but very irregular pips with large windmill-sail petals. I have not tried all these, but those I did were all sterile, both ways.

"The most recent French strain, originating in Jules Chrétien, crosses freely with ours.

"I may also mention that there is a close relation *between colour and fertility* in some zonals, the very dark crimsons being so nearly sterile as to make seed-raising difficult, the sterility being in proportion to the depth of the colour."

This last observation refers to self-fertilisation, and agrees with Darwin's. It is because the flowers are strongly proterandrous. In the paler varieties, as "Christine," they are more nearly homogamous, and consequently are very self-fertile.‡

Dr. Denny found similar inconsistencies among varieties of Pelargonia in 1873. He writes: "I have alluded to the antipathies and affinities we find to exist, without any explicable cause; for instance, I have found it impossible to fertilise three or four varieties of the scarlet Pelargonium (viz. the Duke of Cornwall, Dr. Muret, Beauté de Suresnes, and all that section of the doubles which sprang from Beauté de Suresnes), which to all appearance are mere varieties of the zonal section—save with one another." §

A florist informed me (in 1880) that he found the "rough-leaved" fancy Pelargonia, the flowers of which have a blotch on all five petals

* Communicated by Mr. Krelage, from Mr. J. K. Budde, the curator.
† See also paper by Mr. C. C. Hurst, *Gard. Chron.* Jan. 7, 1899, p. 14 seqq.
‡ See Darwin's *Cross and Self Fertilisation of Plants*, pp. 142 note and 352.
§ *Op. cit.* p. 22.

would not cross with the smoother-leaved forms, the flowers of which have blotches—at least distinct—on two petals only. I do not know how far this has been corroborated, if at all.

Partial Hybridisation.—A feature not infrequently observed by hybridisers is that a result of foreign pollen applied to the stigma of a different species is that it may take effect in varying degrees without securing any fertilisation of the ovules at all.

One of the first botanists to note this fact was Wichura in the case of Willows, in which the following degrees of failure were observed :—

1. "The catkins submitted to hybridisation wither as soon as the flowering is complete, and fall off.

2. "The ovaries swell and mature, but do not contain a trace of seed.

3. "The ovaries are quite filled with the silky hairs which clothe the funicle of the seed, which contains no embryo.

4. "Seeds are present, but small, feeble, and incapable of germination.

5. "Seeds apparently perfectly developed, but do not germinate.

6. "Seeds germinate, but the young plants are weak, and wither in a short time without further development.

"The gradation in the number of seeds was very various. Sometimes the seeds were few, but fertile and active ; sometimes, on the contrary, numerous, but with only a few fertile mixed with a number of abortive seeds ; sometimes tolerably numerous, without any such admixture ; but, in general, hybrids yielded on the whole a smaller number of seeds than plants impregnated with their own pollen." *

The above quotation was published in 1866; but Dean Herbert experienced the same results with Alstrœmerias, and records Mr. Bidwell's crossing *Passiflora cœrulea* with *P. onychina*, which bore a fine orange fruit, but devoid of seeds.†

Similar results have occurred repeatedly since then with other plants. Thus, just as Wichura found that silky hairs were the sole result of pollination in Willows, so is it in Orchids; as, *e.g.*, in an attempt at hybridisation by Mr. Veitch in the case of *Phalænopsis Luddemanniana* × *P. Schilleriana*, *amabilis*, and *grandiflora*. There was no seed, but hypertrophy of the placental hairs, giving the appearance of a pod full of cotton wool.‡ This has also occurred with many other Orchids.

Phalænopsis grandiflora × *Stanhopea tigrina*, as well as *Stanhopea eburna* × *S. tigrina*, developed fruits; but no seed could be obtained which would germinate in the Utrecht Botanic Gardens.§

That the pollen may only affect the fruit is a well-known phenomenon. Thus, for example, Dr. Bonavia crossed the native Pumpkin of India, called *Koomrā*, with the American Squash pollen. The ovary enlarged and came to maturity, but did not contain a single seed. When it is fertilised with its own pollen, it is full of good seed.

Mr. Veitch observes that "neither the Cattleyas nor the Brazilian

* Abstract in *Journ. R.H.S.* New Series, vol. i. p. 63.

† *On Hybridisation amongst Vegetables.*

‡ The reader is referred to *Origin of Floral Structures*, p. 165 seqq., for a discussion on the influence of the pollen-tube upon the ovary.

§ Communicated by Mr. Krelage.

Lælias will cross freely with the Mexican *Lælia albida*, *autumnalis majalis*, *rubescens* (better known in gardens as *acuminata*), &c. Numerous crosses have been effected both ways, and capsules have been produced, but the seed has always proved barren."*

Similarly, Mr. Salter, of Woodhatch, writes me: "*Dendrobium Phalænopsis*, var. *Schroederianum*, was crossed with *D. Ainsworthii*, *D. formosum*, *D. Cassiope*, and *D. heterocarpum*, and the fertilisation seemed perfectly successful; and the pods swelled in the ordinary manner until the ripening season. When, however, they were split open, there was no seed, only a kind of fluff [hypertrophied hairs] upon the internal ridges of the pods."

Sophronitis violacea and *S. grandiflora* have both been crossed, reciprocally, by Mr. Veitch; but although capsules were formed no fertilisation had taken place.

Empty capsules also resulted from crossing *Vanda tricolor* with species of *Angræcum* and *Phalænopsis*. So too between species of *Phalænopsis*. *P. Luddemanniana*, the male parent of some of the finest hybrids of this genus raised, has been crossed with the pollen of well-nigh every species of P. in cultivation; but nothing has yet resulted therefrom. The application of the pollen of species of P. to the stigma of *P. Ludd.* stimulates the ovary into growth, but seems to be impotent to fertilise the ovules. Similar results have attended *P. violacea* when used as the female parent, with the single exception of the hybrid *P. Ludd. violacea* raised from it, and *P. Ludd.*, male. The above result, which is Mr. Veitch's experience, was repeated in the cases of *Cymbidium* male × *C. Lowianum*, *C. giganteum*, and *C. Traceyanum*; and several other genera gave similar results.

Lastly, *Campanula Van Houttei*, believed to be a hybrid, as it is generally barren, was crossed by Mr. E. Scaplehorn with *C. mirabilis*. The ovary enlarged and contained ovules, but the latter were deformed, yet much larger than in the case of those not crossed, proving that a partial impregnation had taken place. A similar result followed on crossing the first named with *C. medium*.

A general result is seen in a hybrid, or bi-gener, vegetating freely and healthily, but failing in various degrees in its reproductive system. It may show in its leaves &c. every intermediate character, or none at all, being exactly, to all appearances, like one of the parents. Results of this kind have followed attempts to cross Geraniums with Pelargoniums, *Abutilon* with *Hibiscus*, Raspberry with Strawberry, and Gooseberry with Black Currant. With regard to the last two, the former of them has flowered but borne no fruit, while the latter has borne fruit as well.

False Inferences from Failures.—That a cross may fail in one season and not in another shows that no absolute rule can be laid down, as in the following case in the experience of Dr. Bonavia, who writes me as follows: "When in India I imported a Dutch *Hippeastrum*. It flowered. At the same time I had a large number of Lucknow Hippeastrums in flower. I endeavoured to cross the Dutch H. with the Indian ones; but no result occurred either with the Dutch pollen or the reverse. I tried the same experiment in the next year, again with

* *Gard. Chron.* May 16, 1885, p. 630.

no result whatever. But in the third year I tried again, both ways, and I got a number of seeds in each case, which germinated. It struck me that possibly either the Dutch bulb was too young or that it was not sufficiently acclimatised to afford results either with its pollen or its pistil; for the climate, or the season, or the cultivation &c. may interfere with a successful result."

Mr. C. C. Hurst has given us the following important conclusion from his own experiences: "The nigro-hirsute section of Dendrobiums are well known to be bad setters. Mr. R. Eichel, of Bradford, tells me that for eight years he has failed to cross *D. formosum* with pollen of the deciduous section; but that he has now seedlings two and a half months old of *D. formosum* × *D. nobile* (male) from four seed-pods. This circumstance proves to us once more how misleading and unsatisfactory purely negative results are, and in this there is much hope for the future. However many times a cross has failed to set, we can never be sure that it may not be accomplished by some one. Very trifling conditions seem to affect the delicate and susceptible organs of reproduction, causing apparent sterility. For instance, it is said that *Epidendrum ciliare* can only be fertilised with success in the evening, when the flowers begin to emit their fragrant perfume; though this did not prove to be the case with Mr. Veitch."

One of the most unlikely results occurred with Poppies. M. Henry L. de Vilmorin succeeded in raising a hybrid between *Papaver bracteatum* and one of the double-flowered varieties of *P. somniferum*. The seedlings were annuals, and bore single carmine-coloured flowers. At first the plants were nearly all sterile; but subsequently seed was freely produced.*

With regard to Ferns, Stelzner † describes the hybridisation of two species of *Gymnogramma*, viz. *G. chrysophylla* and *G. lanata*. One plant so raised was so different from the parents that Koch named it *G. Stelzneriana*. It proved to be entirely barren. But in 1864 ‡ he repeated the experiment, and had a number of plants of the hybrid, all of which were wholly fertile.

M. Naudin experienced a similar result with Daturas: thus, "*D. lævis, ferox, Stramonium,* and *quercifolia,* four species perfectly distinct, between which there are no known intermediates, and moreover they do not appear susceptible of variation. Nevertheless, though very distinct, these species are sufficiently closely related to admit of reciprocal impregnation, and to give rise to hybrids; which, though sterile at first, become very fertile at a more advanced period." §

One cannot do better than conclude with the hopeful advice of Dean Herbert, in alluding to the artificial separation of genera by botanists: "Let the cultivator not be discouraged by every nominal generic separation; but let him take his own view of apparent affinities, and bring the accuracy of those separations to the test." ||

* *Gard. Chron.* 1896, Jan. 11, p. 50.

† *Wochenschrift*, Berlin, 1859.

‡ *Bull. Bot. Cong.*, Amsterdam, 1866.

§ "On Hybridism considered as a Cause of Variability in Vegetables," *Journ. R.H.S.* New Series, vol. i. p. 1.

|| Essay on *Hybridisation amongst Vegetables*.

Discussion.

The Ven. Archdeacon Meredith : You said, Professor Henslow, that the French Pelargonium would not hybridise with the English. Are there any special characteristics by which the French Pelargonium is known; or would any other Pelargonium hybridise with the English?

Professor Henslow : The report was sent to me by one of the numerous friends I have to thank for a variety of information. There was no other remark on the subject, merely the statement of the fact.

Archdeacon Meredith : I have tried it myself, but have generally failed.

Professor Henslow : Then that corroborates my informant.

Archdeacon Meredith: Are there any differences between Pelargoniums grown in other countries, such as Germany or America?

Professor Henslow: That I cannot tell you. I am passing on my information just as I received it.

Archdeacon Meredith: Is it possible for plants to get naturalised to the particular country where they are reared? After a time do they lose their foreign characteristics?

Professor Henslow: I think that is so. As I have said the Primula, according to Mr. Sutton, will not now cross with the original form from which it is derived—the Chinese form. I do not know of any other instance; perhaps other cultivators may know.

Mr. George Bunyard, V.M.H.: I would like to say that a gentleman in our neighbourhood has made many curious crosses, among which is one of the Gooseberry and the Blackcurrant. He succeeded in producing fruit on it, and I tasted it; but it was of no use whatever from a commercial point of view, and I did not entertain his offer to sell the plant to me. He also had a cross between the Blackcurrant and *Ribes sanguinea*, and between the *Ribes sanguinea* and the Gooseberry (p. 168).

Professor Henslow: Do you know whether the seed was retained?

Mr. Bunyard: Yes.

Professor Henslow: That is an advance on the information that I possessed.

NOTES ON SOME EXPERIMENTS IN HYBRIDISATION AND CROSS-BREEDING.

By Mr. C. Chamberlain Hurst, F.L.S.

During the past few years the question of inheritance has been of increasing interest to students of Evolution as well as to the practical breeder.

Since the foundation-stone of the subject was laid by Charles Darwin in the standard work, "Animals and Plants under Domestication," our knowledge of one part of it has considerably increased. Thanks to recent improvements in the mechanism of the microscope, and the consequent facilities for studying the inner processes of fertilisation, the tendency has been for students of heredity to give most of their attention to the mysteries of the germ-cells and the part they play in sexual reproduction. This is, undoubtedly, very desirable and very necessary; yet, on the other hand, there seems to be a danger that in so doing we may lose sight of the broad facts of inheritance as manifested to us in the outward characters of plants and animals. And it seems to me that, notwithstanding the great body of facts already brought together by Darwin in his magnificent work, there is still a wide field open to the student in making further experiments and in gathering fresh facts.

The aim of this paper is to record, as concisely as possible, some experiments in the hybridisation and cross-breeding of plants, carried out by myself and others, which seem to bear directly upon the problems of inheritance and variation.

The Inheritance of Varietal Characters.

From the horticultural point of view, the inheritance or non-inheritance of varietal characters is most important. If a useful or ornamental variety be capable of transmitting its good qualities to its offspring, then its own natural value becomes greatly enhanced, and in the course of a few generations a more or less permanent race may be established. Most breeders have a strong impression that varieties possess the power of transmitting their qualities to their offspring, and in practice they take care to breed only from the best which suit their purpose, in the hope that the improvement may be maintained, and, if possible, increased. But, having observed many exceptions to that general rule, in the Orchideæ, I have thought it worth while to consider the question somewhat in detail. Take, first of all, a natural variety fertilised with its own pollen; in this case, if a varietal character be hereditary at all, it should, *à priori*, be especially so when fertilised with its own pollen. Paphiopedilum Lawrenceanum Hyeanum is a colour form of the type, in which all the purple and brown colouring matter is suppressed, leaving the whole plant shades of green and white. Mr. Norman Cookson, of Wylam-on-Tyne, fertilised this variety with its own pollen, and a batch of seedlings was raised.

The first eight plants that flowered reproduced exactly the characters of the parental variety, P. L. Hyeanum, but the ninth one reverted to an ordinary form of the type P. Lawrenceanum. P. insigne Sanderæ is a variety in which nearly all the brown and green colouring matter of the type has vanished, leaving the variety shades of yellow and white. Mr.

FIG. 9.—PAPHIOPEDILUM INSIGNE SANDERÆ. (*Orchid Review.*)

Norman Cookson has also raised this perfectly true from self-fertilised seed. (Fig. 9.)

P. × *Harrisianum Rossianum* is a striped variety or sport of a light-coloured hybrid between P. villosum and P. barbatum, in which the colours of the two parents, in the flowers, lie side by side, instead of being fused together as in the type, giving the variety a curious harlequin appearance. Mr. H. J. Ross, of Florence, fertilised this variety with its

own pollen, and the first plant which flowered reproduced the varietal characters faithfully, while the second one reverted to the light-coloured original form.

Dendrobium nobile Cooksonianum is an abnormal variety, with the petals coloured somewhat as in the lip (irregular peloria). This variety was crossed by Mr. Cookson with D. n. nobilius, a variety with deep purple sepals and petals; and from the same seed capsule were raised both D. n. Cooksonianum and D. n. nobilius true to character, together with a series of reversionary forms grading down to the ordinary type of *D. nobile.*

On the other hand, Mr. Fred Hardy, of Ashton-on-Mersey, crossed a large form of the typical *D. nobile* with pollen of *D. n. Cooksonianum*, and, though the seedlings resulting therefrom varied considerably, not one had the characteristics of D. n. Cooksonianum.

Again. Mr. Cookson crossed D. n. Cooksonianum with pollen of D. n. Burfordiense, the latter being a variety with the two lower sepals coloured like the lip, instead of the petals, as in D. n. Cooksonianum. One of these seedlings reproduced D. n. Burfordiense truly.

Mr. Cookson also crossed D. n. Burfordiense with a distinct species, D. Findlayanum, and raised a hybrid known as D. × Cybele, Oakwood var., and all the plants reproduced the characteristic blotch on the lower sepals as in D. n. Burfordiense. (Fig. 10.) Both D. n. Cooksonianum and D. n. Burfordiense are technically anomalies, being cases of irregular peloria; and they seem to reproduce their sportive characters in their offspring either wholly or not at all, there being no intermediate forms between them and the normal.

D. × Cybele, Oakwood var., mentioned above, is a good illustration of the inheritance of varietal characters, especially when we remember that the typical D. nobile, crossed with D. Findlayanum, produces the typical D. × Cybele; and again, when D. n. nobilius, a richly coloured variety of the type, is crossed with D. Findlayanum, the result is D. × Cybele nobilius, a correspondingly coloured variety of the typical hybrid.

D. nobile crossed with D. Falconeri produces the typical D. × Venus, but when D. n. nobilius is used as one parent D. × Venus magnificum is produced, its colour being correspondingly deeper than the type.

D. nobile crossed with D. aureum gives the typical D. × Ainsworthii; but Messrs. Veitch & Sons, of Chelsea, by using special varieties of each species as parents, produced D. × Ainsworthii splendidissimum, a greatly improved form. On the other hand, a partial exception may be quoted where D. n. nobilius, crossed with D. aureum, produced D. × Ainsworthii Edithæ, a light-coloured form of D. × Ainsworthii splendidissimum, inheriting the form of D. n. nobilius, but not the colour.

Mr. Cookson crossed the typical D. nobile with the typical D. × Ainsworthii, and raised a light-coloured form called D. × Apollo.

Mr. J. Cypher, of Cheltenham, and Mr. C. Winn, of Birmingham, crossed D. n. nobilius with D. × Ainsworthii splendidissimum, and raised the correspondingly deep-coloured D. × Rubens; while the Hon. Oakes Ames, of Massachusetts, raised an almost identical hybrid from the

reverse cross; but, on the other hand, Mr. R. B. White, of Ardarroch, raised a rosy-coloured form of D. × Rubens, nearer to the type, from the same cross.

Again Baron Schröder crossed D. n. Schröderianum, a variety with white sepals and petals, with D. × Ainsworthii splendidissimum, which

FIG. 10.—DENDROBIUM × CYBELE, VAR. OAKWOODIENSE. (*Gardeners' Chronicle.*)
(D. NOBILE BURFORDIENSE × D. FINDLAYANUM.)
Showing the Inheritance of the Peloriate Sepals of D. n. Burfordiense.

produced D. × R. dellense, also with white sepals and petals, and Mr. Cypher crossed D. n. pulcherrimum, also a variety with white sepals and petals, with D. × Ainsworthii splendidissimum, which produced D. × R. Apollo and D. × Apollo grandiflorum, both with white sepals and petals.

The original D. Wardianum from Assam, with slender pseudo-bulbs, crossed with D. lituiflorum by Messrs. Veitch, gave D. × micans with slender pseudo-bulbs, whereas the modern D. Wardianum from Burma,

with stout pseudo-bulbs, gives D. × micans with pseudo-bulbs correspondingly stout.

Varietal characters seem also to be generally inherited in the Cypripedium group; for instance, Paphiopedilum insigne crossed with P. Spicerianum produced the typical hybrid P. × Leeanum, with Sir Trevor Lawrence; but when P. i. Maulei or P. i. Chantini were used as parents by Messrs. Veitch and Mr. Winn, P. × Leeanum superbum was the result, the offspring in these cases corresponding with the parents' varieties in having a larger area of pure white, and being much broader in the upper sepal of the flower. Again, when the densely spotted P. i. Wallacei was used as a parent by M. Jules Hye-Leysen, of Ghent, the densely spotted P. × Leeanum Albertianum was the result; while the yellow P. i. Sanderæ gave with Messrs. Veitch the yellowish P. × Leeanum Prospero, and the large P. i. giganteum gave with Messrs. Heath, of Cheltenham, the large P. × Leeanum giganteum. Finally, P. i. Chantini crossed with P. Spicerianum roseum gave with Hon. Erastus Corning, Albany, U.S.A., the richly coloured P. × Leeanum roseum. In the same way, the typical P. insigne crossed with P. villosum gives P. × nitens Sallierii, while P. i. Chantini and P. i. Maulei give P. × nitens, P. × n. superbum, P. × n. Celeus, and P. × n. giganteum; all being superior forms, showing clearly the larger flowers, broader upper sepal, and white area of the parent varieties. Similarly, the typical P. insigne crossed with P. barbatum gives the typical P. × Ashburtoniæ, while the variety P. i. Chantini, with M. Bauer, of Paris, gave P. × A. Barteti and P. × A. Laforcadei, both showing the varietal characters of the parental variety. In the same way, the typical P. insigne, crossed with P. Fairieanum, gave with Messrs. Veitch the typical P. × Arthurianum; but when their Mr. Seden used P. i. Chantini as the parent, the result was P. × A. pulchellum, in which the characters of the parental variety are marked. Again, the typical P. barbatum crossed with P. bellatulum, with several raisers, has given the typical P. × Richmanii, with nearly horizontal petals, while P. barbatum Crossii, with drooping petals, when used as the parent in this cross, has given P. × R. Leysenianum, P. × R. "François Peeters," and P. × R. "Lilian Greenwood," all with pendent petals.

Two apparent exceptions to the above may be cited: P. b. Crossii crossed with P. Charlesworthii gave P. × barbato-Charlesworthii, with nearly horizontal petals, and P. b. Crossii crossed with P. Spicerianum gave P. × Eyermannianum Hermione, with nearly horizontal petals.

P. Boxalli crossed with P. hirsutissimum with Mr. Cookson, gave the typical P. × Godseffianum, but the dark-coloured variety P. B. atratum, used by M. Desbois, gave the dark-coloured P. × G. Jupiter. In the same way P. Boxalli crossed with P. Spicerianum, by Messrs. Veitch, gave the typical P. × Calypso, while P. × B. atratum, used by Mr. Winn and Mr. Cookson, gave the darker forms, P. × C. Winn's var., P. × C. Armstrongianum, and P. × C. Oakwood var. Similarly P. Boxalli, crossed with P. barbatum, gives P. × apiculatum, while P. B. atratum gives P. × a. atratum.

In another section of the Cypripedium group the inheritance of varietal characters still holds good to a large extent. For instance, Phragmi-

FIG. 11.—PHRAGMIPEDILUM CAUDATUM WALLISII. (*Orchid Review.*)
Showing normal Lip.

pedilum Schlimii crossed with P longifolium, with Messrs. Veitch, gave the typical P. × Sedenii (the reciprocal cross, too, being exactly the same), whereas P. Schlimii albiflorum, with light-coloured flowers, gave P. × Sedenii candidulum, with light-coloured flowers; while P. Schlimii, crossed with P. longifolium Roezlii, with dark-coloured flowers, gave P. × Sedenii porphyreum, with dark-coloured flowers. Similarly, P. longifolium crossed with P. caudatum gave the typical P. × grande, while the darker variety, P. l. Roezlii, gave the darker P. × grande atratum.

One of the most distinct and interesting varieties in the Cypripedium

FIG. 12.—PHRAGMIPEDILUM × SCHRÖDERÆ. (*Orchid Review.*)
(P. CAUDATUM ♀ × P. SEDENII ♂.)
Hybrid from P. caudatum with the normal Lip of its Parent.

group is Phragmipedilum caudatum Lindenii, a natural peloriate variety so distinct that, when it was first introduced, Lindley created a new genus for it. It is peculiar in being lipless, the place of this organ being occupied by a long petal-like segment which sometimes measures twenty inches in length; it has also a third fertile stamen inserted below the stigma at the base of the column. This curious plant was first found growing wild in Rep. Colombia, by the late M. Jean Linden, of Brussels, in 1843, and has since been found by later collectors in other localities, so that apparently it must breed true to character in its own habitat. There is not much doubt, however, that it is simply a peloriate form of

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(To face page 97.)

P. caudatum, for a flower once appeared on a typical P. caudatum midway between this curious variety and the type.* This curious variety, P. c. Lindenii, is interesting from another point of view. In its native home it apparently breeds true to character, yet when crossed with other species its curious characters do not appear to be reproduced at all. For instance, it has been crossed with P. longifolium, giving P. × grande macrochilum (fig. 14); with P. × conchiferum, giving P. × Clonius; with P. × Ainsworthii calurum, giving P. × Penelaus (fig. 13); and with P. × grande, giving P. × macrochilum, and in no case has its curious lipless character been transmitted. It would be interesting if someone would fertilise this curious variety with its own pollen, or cross it back again with one of the four hybrids of which it has been a parent, and record the result.

Many more instances of inheritance and non-inheritance of varietal characters in the Orchideæ might be recorded, but space will not permit any more. Suffice it to say that a general survey of the whole of the facts has brought me to the following conclusions :—

(1) Distinct varieties tend to transmit their qualities, especially if fertilised with their own pollen, though exceptions are not rare.

(2) The chief exceptions seem to arise where the parents or the ancestors of the variety have been variable.

(3). Slight variations are seldom hereditary.

(4) Abnormal sports are generally transmitted wholly or not at all.

(5) Distinct varieties, as a general rule, transmit their qualities in different degrees, sometimes wholly, sometimes partly, and at other times not at all.

(6) Varietal characters can seldom be traced in the second or following generations, unless they happen to recur on both sides of the pedigree.

(7) The law of Partial Prepotency, elaborated further on in this paper, may possibly account for these varied results in the inheritance of varietal characters.

The Inheritance of Specific Characters.

Those who have studied hybrids between distinct species must be impressed with the undoubted inheritance of specific characters.

Varietal characters, while perhaps of more practical importance, are yet so indefinable, so uncertain, and so fleeting that in the second generation they are with difficulty traced at all. On the other hand, specific characters are more definable, more certain, and more lasting, and can be traced through several generations. For instance, in Paphiopedilum × triumphans, a hybrid of the third generation raised by M. Jules Hye-Leysen, of Ghent, the crimson veining in the upper sepal of the flower can be traced through the parent, P. × œnanthum superbum, and the grandparent, P. × Harrisianum, back to the great-grandparent, P. barbatum.

In studying the inheritance of specific characters, I have found it a great advantage to take up a special group of plants and to study their

* See Dr. Maxwell Masters, in Veitch's "Manual of Orchids," x. 1894, p. 45, figs. 6, 7.

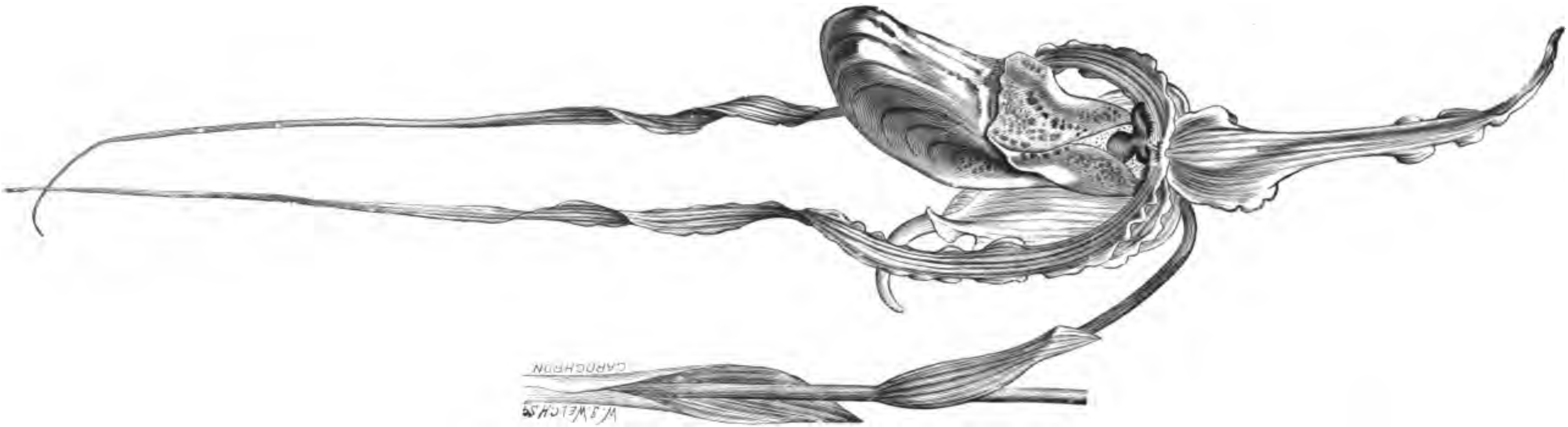

FIG. 14.—PHRAGMIPEDILUM × GRANDE, VAR. MACROCHILUM. (*Gardeners' Chronicle.*)
(P. LONGIFOLIUM ♀ × P. CAUDATUM, VAR. LINDENII ♂.)
With normal Lip; the abnormal Lip of P. c. Lindenii not inherited.

characters as carefully and minutely as a monographer would do, and in this way I have been able to follow the inheritance of specific characters much more easily than otherwise I could have hoped to do. In following out this idea I have chosen the orchideous genus Paphiopedilum (Pfitz), better known in gardens as Cypripedium, partly because hybridisation has been carried farther in this genus than in many others, and partly because I have the good fortune to have a large collection of living hybrids and their parents of this genus under my own observation from day to day.

The limits of this paper will not allow fully detailed observations, but a few condensed analyses of some primary hybrid Paphiopedilums will well illustrate the inheritance of specific characters. In these cases practically the whole plant has been analysed from living specimens, twenty points in all being taken into consideration :—

(1) The habit of growth; (2) the habit of flowering; the form or shape of the (3) leaves, (4) scape, (5) bract, (6) ovary, (7) upper sepal, (8) lower sepal, (9) petals, (10) lip or slipper, (11) staminode; the colour of the (12) leaves, (13) scape, (14) bract, (15) ovary, (16) upper sepal, (17) lower sepal, (18) petals, (19) lip or slipper, (20) staminode.

Each of these parts or organs of the hybrid has been compared with the same part of each of the parent species. Each part is then classed in relation to the two parents, either (*a*) in the ratio as 1 : 1, which represents the part as fairly intermediate between the two parents; or (*b*) in the ratio as 3 : 2, which represents one parent to be slightly predominant in that particular part; or (*c*) in the ratio as 2 : 1, showing the decided prepotency of one parent in that part; or (*d*) in the ratio as 3 : 1, showing the very large prepotency of one parent in that part. In this way the twenty parts are classified, and when the various figures are added together one can see at a glance the total ratio of one parent to the other in the hybrid. In the following condensed analyses I have ignored, for the sake of simplicity, all the ratios as 1 : 1 and also those as 3 : 2, classing them as intermediate or thereabouts, and only showing the undoubted prepotencies of either parent in the ratios as 2 : 1 and over. At the end of each are given the full ratios of the plant as a whole, as originally analysed, with the corresponding percentages of the predominant parent, for the sake of comparison. (For additional instances, see also under the heading of "Variation of Primary Hybrids.")

(1) *Paphiopedilum* × *Winnianum*, a hybrid raised by Messrs. Veitch, of Chelsea, out of P. villosum (Pfitz) by P. Druryi (Pfitz). *In form*, the parent P. Druryi is prepotent in habit of growth, leaves, scape, and lower sepal; while P. villosum predominates in habit of flowering, petals, and staminode; in all, favouring P. Druryi as 18 : 17. *In colour*, P. Druryi preponderates in the leaves, lower sepal, and staminode; while P. villosum prevails in the petals; altogether favouring P. Druryi as 16 : 15. The whole plant in form and colour favouring P. Druryi as 34 : 32, or 51·5 per cent.

(2) *P.* × *Swinburnei*, a hybrid raised by Messrs. Heath, of Cheltenham, out of P. insigne (Pfitz) by P. Argus (Pfitz). *In form*, the parent P. insigne is prepotent in bract, ovary, and upper sepal; while P. Argus

predominates in the lip; in all, favouring P. insigne as 24 : 23. *In colour*, P. Argus predominates in lower sepal, petals, and lip, altogether favouring that parent as 19 : 15. The whole plant, in form and colour favouring P. Argus as 42 : 39, or 51·8 per cent. (Fig. 16.)

(3) *P.* × *Ceres Medea*, a hybrid between P. Spicerianum (Pfitz) and P. hirsutissimum (Pfitz), raised by Mr. Latham, of Birmingham. *In form*, the parent P. Spicerianum is prepotent in the upper sepal, while P. hirsutissimum predominates in the leaves, ovary, and staminode; in all, favouring P. hirsutissimum as 20 : 19. *In colour*, P. Spicerianum preponderates in the leaves, bract, upper sepal, and staminode; while P. hirsutissimum prevails in the scape and petals, altogether favouring P. hirsutissimum as 16 : 15. The whole plant, in form and colour, favouring P. hirsutissimum as 36 : 34, or 51·4 per cent. (Fig. 17.)

(4) *P.* × *Arthurianum*, a hybrid out of P. Fairieanum (Pfitz) by

FIG. 15.—P. × SELLIGERUM. FIG. 16.—P. × SWINBURNEI. FIG. 17.—P. × CERES MEDEA.
HYBRID PAPHIOPEDILUMS.

P. insigne (Pfitz), raised by Messrs. Veitch. *In form*, the parent P. insigne is prepotent in the upper sepal, while P. Fairieanum predominates in the lip and staminode; in all, favouring P. Fairieanum as 23 : 20. *In colour*, P. insigne preponderates in the scape and upper sepal, while P. Fairieanum prevails in the staminode; altogether, intermediate, as 16 : 16. The whole plant, in form and colour, favouring P. Fairieanum as 39 : 36, or 52 per cent.

(5) *P.* × *conco-villosum*, a hybrid between P. concolor (Pfitz) and P. villosum (Pfitz), raised by Messrs. Charlesworth, of Bradford. *In form*, the parent P. concolor is prepotent in the leaves and lip, while P. villosum predominates in bract and ovary; in all, favouring P. villosum as 23 : 22. *In colour*, P. concolor preponderates in the lower sepal and lip, while P. villosum prevails in the leaves and bract; altogether favouring P. concolor as 15 : 12. The whole plant, in form and colour, favouring P. concolor as 37 : 35, or 51·3 per cent.

(6) *P.* × *Ashburtoniæ Laforcadei*, a hybrid raised by M. Bauer, of Paris, out of P. barbatum by P. insigne Chantini. *In form*, the parent P. barbatum is prepotent in habit of growth, leaves, lip, and staminode; while P. insigne preponderates in the lower sepal and petals; in all, favouring P. barbatum as 20 : 18. *In colour*, P. insigne predominates in the lower sepal. Altogether the hybrid is fairly intermediate, as 15 : 15. The whole plant, in form and colour, favouring P. barbatum as 35 : 33, or 51·4 per cent. (Fig. 20.)

(7) *P.* × *apiculatum*, a hybrid raised by Mr. D. V. Drewett, of Riding-Mill-on-Tyne, out of P. barbatum (Pfitz) by P. Boxalli (Pfitz). *In form*, the parent P. barbatum is prepotent in habit of growth, leaves, and staminode, while P. Boxalli predominates in the petals; in all, favouring

FIG. 18. P. × APICULATUM. FIG. 19. P. × LATHAMIANUM I. FIG. 20. P. × ASHB. LAFORCADEI.

FIG. 21. P. BOXALLI. FIG. 22. P. × RUBESCENS. FIG. 23. P. INSIGNE MACULATUM.

PAPHIOPEDILUMS.

P. barbatum as 26 : 21. *In colour*, P. Boxalli preponderates in the bract, petals, and lip, while P. barbatum prevails in the staminode; altogether favouring P. Boxalli as 19 : 15. The whole plant, in form and colour, favouring P. barbatum as 41 : 40, or 50·6 per cent. (Fig. 18.)

(8) *P.* × *selligerum*, a hybrid out of P. barbatum (Pfitz) by P. philippinense (Pfitz), raised by Messrs. Veitch. *In form*, the parent P. barbatum is prepotent in the leaves, while P. philippinense predominates in habit of flowering, ovary, and lower sepal; in all, favouring P. philippinense as 20 : 19. *In colour*, P. barbatum preponderates in the lip, while P. philippinense prevails in the leaves and lower sepal; altogether fairly intermediate, as 16 : 16. The whole plant, in form and colour, favouring P. philippinense as 36 : 35, or 50·8 per cent. (Fig. 15).

(9) *P.* × *Doncasterianum II.*, a hybrid between P. hirsutissimum (Pfitz) and P. callosum (Pfitz), raised by Messrs. Charlesworth. *In form*, the parent P. callosum is prepotent in habit of flowers, scape, bract, ovary, lower sepal, and staminode, while P. hirsutissimum predominates in the leaves and lip; in all, favouring P. callosum as 24: 20. *In colour*, P. callosum preponderates in scape, ovary, lower sepal, lip and staminode, while P. hirsutissimum prevails in leaves, bract, and petals; altogether fairly intermediate, as 15 : 15. The whole plant, in form and colour, favouring P. callosum as 39: 35, or 52·7 per cent.

(10) *P.* × *Quies II.*, a hybrid between P. Curtisii and P. Hookeræ volonteanum, raised by Messrs. Charlesworth. *In form*, the parent P. Hookeræ is prepotent in habit of flowering, scape, and lip, while P. Curtisii predominates in habit of growth, bract, ovary, and petals; in all, fairly intermediate, as 19 : 19. *In colour*, P. Hookeræ preponderates

FIG. 24. EPI-LÆLIA × RADICO-PURPURATA. FIG. 25. EPIDENDRUM RADICANS.
(*Orchid Review.*)
Generic Hybrid with its prepotent Pollen Parent.

in the ovary and upper sepal, while P. Curtisii prevails in the bract; altogether favouring P. Hookeræ as 17 : 16. The whole plant, in form and colour, favouring P. Hookeræ, as 36 : 35, or 50·7 per cent.

From the above analyses it will be seen that in primary hybrids between two species the amount of the inheritance of the specific characters of each parent is found to be about one-half.

THE INHERITANCE OF GENERIC CHARACTERS.

Generic hybrids, or bigeners, *i.e.* hybrids between species belonging to two distinct genera, have now become rather numerous, especially in the Orchideæ, in that order numbering about 150 distinct crosses. As a rule it is found that generic characters, like specific characters, are inherited in primary hybrids to the amount of one-half or thereabouts.

An interesting illustration of this may be seen in the structure of the pollinia in the many hybrids between Cattleya and Lælia.

The genus Cattleya (Lindl.) has four pollinia of equal size, arranged in one row, while Lælia (Lindl.) has eight pollinia of equal size, arranged in two rows of four each, being generally somewhat smaller than those of Cattleya.

The hybrid genus Lælio-Cattleya × (Rolfe), obtained by crossing these two genera, has eight pollinia, arranged in two rows of four each, as in the parent Lælia; but in the lower row the pollinia are large and of equal size, as in the parent Cattleya, while in the upper row they are small, uneven, and apparently rudimentary. In this way the generic characters of both parents are inherited.

Generic characters appear to be more powerful and more lasting than either specific or varietal characters, persisting, little changed, for several generations, possibly more; and would, no doubt, be much more difficult to breed out than either specific or varietal characters.

For example, Lælio-Cattleya × leucoglossa, raised by Messrs. Veitch, is a hybrid of the third generation, whose pedigree may be seen at a glance in the following diagram:—

Diagram showing the two parents, four grandparents, and eight great-grandparents of Lælio-Cattleya × leucoglossa.

<table>
<tr><td>C.
L.
♀</td><td>C.
L.
♂</td><td>C.
L.
♀</td><td>C.
L.
♂</td><td>C.
L.
♀</td><td>C.

♂</td><td>Cattleya
Mossiæ
(Hook.)</td><td>Lælia
crispa
(Rchb.f)</td></tr>
<tr><td colspan="2">C.
L.
♀</td><td colspan="2">C.
L.
♂</td><td colspan="2">C.
L.
♀</td><td colspan="2">Lælio-Cattleya
× exoniensis
(Veitch)
♂</td></tr>
<tr><td colspan="4">Cattleya
Loddigesii
(Lindl.)
♀</td><td colspan="4">Lælio-Cattleya
× fausta
(Veitch)
♂</td></tr>
</table>

Lælio-Cattleya × leucoglossa (Veitch).

According to Mr. Galton's law of ancestral heredity, this hybrid *should* contain in its pedigree $\frac{1}{2}$ C. Loddigesii + $\frac{1}{4}$ L.-C. × fausta + $\frac{1}{8}$ C. Loddigesii + $\frac{1}{16}$ L.-C. × exoniensis + $\frac{1}{32}$ C. Mossiæ + $\frac{1}{32}$ L. crispa; or, to reduce it to more simple terms, $\frac{3}{4}$ C. Loddigesii + $\frac{1}{8}$ C. Mossiæ + $\frac{1}{8}$ L. crispa; that is to say, $\frac{7}{8}$ Cattleya + $\frac{1}{8}$ Lælia. Yet, when we come to examine the generic characters of

this complex hybrid, we find that it is a pure Lælio-Cattleya, having eight pollinia in two rows of four each, the upper row being small and apparently rudimentary; and although the Lælia parentage is only represented to the extent of $\frac{1}{8}$, yet the generic characters are the same as if it had been $\frac{1}{2}$. In other words, through its parent and grandparent the hybrid has inherited the generic characters of one of its great-grandparents, while the specific characters of that ancestor can be traced but little, and the varietal characters not at all.

Generic hybrids in the Orchideæ have produced many anomalies; for instance, when the species of Lælia, Cattleya, and Sophronitis are intercrossed, normal hybrids are produced, intermediate in their generic characters; but when species of Lælia, Cattleya, and Sophronitis are crossed with the reed-like species of Epidendrum, the latter genus is always prepotent to a remarkable extent, completely swamping the other genera, no matter how they may have been crossed; yet, in every case, in specific and varietal characters, one can easily trace the influence of the other parents, thus proving that *the cross* has been really and truly made.

Seven positive cases, and no negative ones, of these prepotent Epidendrum crosses are on record, and all agree in this curious generic prepotency.

(1) Epiphronitis × Veitchii, raised by Messrs. Veitch out of Sophronitis grandiflora (Lindl.) by Epidendrum radicans (Pav.).

(2) Epi-Cattleya × matutina, raised by Messrs. Veitch out of Cattleya Bowringiana (Veitch), by Epidendrum radicans.

(3) Epi-Lælia × radico-purpurata, raised both by Messrs. Veitch and Messrs. Charlesworth out of Lælia purpurata (Lindl.), by Epidendrum radicans. (Figs. 24 and 25.)

(4) Epi-Lælia × Charlesworthii, raised by Messrs. Charlesworth out of Lælia cinnabarina (Lindl.), by Epidendrum radicans.

(5) Epi-Cattleya × 'Mrs. James O'Brien,' raised by Messrs. Veitch out of Cattleya Bowringiana, by Epidendrum × O'Brienianum (Veitch), the latter parent being itself a hybrid out of E. evectum (Hook. f.), by E. radicans.

(6) Epi-Lælia × heatonensis (Charlesworth), out of Lælia cinnabarina, by Epidendrum × O'Brienianum.

It is difficult to account for this anomaly, but I have suggested in another place that possibly the aristocratic Cattleya and Lælia, as well as the more modest Sophronitis, are all descended—or should it not be *ascended*?—from a lowly reed-like Epidendrum ancestor, and, when crossed with their poor relations, tend to revert to their common ancestor. In addition to these Epidendrum hybrids there are eleven curious crosses between very distinct genera, which, strangely enough, have all reproduced the characters of their seed-parents almost exactly.

(1) Zygopetalum Mackayi ♀ crossed with Odontoglossum nobile (Pescatorei) ♂, both by Messrs. Veitch, of Chelsea, and by Messrs. Heath, of Cheltenham, produced over 300 plants, of which more than twenty flowered Z. Mackayi pure and simple (the remainder were thrown away unflowered, but all were evidently the same species).

(2) Zygopetalum Mackayi ♀ crossed with Odontoglossum crispum ♂.

(3) Z. Mackayi ♀ crossed with O. grande ♂.

(4) Z. Mackayi ♀ crossed with O. bictonense ♂.

(5) Z. Mackayi ♀ crossed with Lycaste Skinnerii, all by Messrs. Veitch, produced a few seedlings of each cross, all of which flowered pure Z. Mackayi.

(6) Z. Mackayi ♀ crossed with Oncidium unguiculatum ♂, by Rev. F. D. Horner, of Burton-in-Lonsdale, and by a Florentine hybridist, both produced Z. Mackayi, pure and simple, four plants being raised.

(7) Epidendrum × O'Brienianum ♀ crossed with Dendrobium crystallinum ♂, by Mr. Statter, of Stand Hall, near Manchester, produced a large number of plants, all of which flowered E. × O'Brienianum.

(8) Phragmipedilum longifolium Hartwegii ♀ crossed with Paphiopedilum Stonei ♂, by Mr. R. M. Grey, for Mr. Graves, of Orange, Mass., produced a plant which flowered Phrag. longifolium Hartwegii.

(9) Phrag. × Sedenii ♀ crossed with Paph. Stonei ♂, by Mr. Statter, produced a plant which flowered Phrag. × Sedenii (as far as one could determine from a somewhat imperfect first flower). I also have an unflowered plant of the same cross, which is undoubtedly a Phragmipedilum in its habit of growth, and form and colour of leaves.

(10) Lælia harpophylla ♀ crossed (curiously enough) with Paphiopedilum villosum ♂ (belonging to a distinct *sub-order*) and the reverse cross, viz.—

(11) Paph. villosum ♀ × Lælia harpophylla ♂, both raised by a well-known expert hybridist in the North of England, have produced plants, yet unflowered, which I have seen and examined, and which, in each case, have the habit and characteristics of their respective seed-parents, No. 10 being evidently true Lælia and No. 11 true Paphiopedilum.

Here we have eleven distinct crosses between nine very distinct genera, all of which have produced "false hybrids," reproducing the characters of their seed-parents absolutely unmodified by the so-called pollen-parents. Nor are these mere solitary exceptions, for as far as experiments have yet been made they seem to be the absolute rule with no exception; in one case, as we have seen, no less than 300 plants were raised from one capsule, all with the same result. These curious crosses are evidently very different from the prepotent Epidendrum hybrids, for in the latter it was the pollen-parent that was prepotent, and all of them were slightly modified by the influence of the other parent, showing them to be true hybrids. But those now under consideration are evidently not true hybrids at all, showing no *trace* of one of the so-called parents.

In the face of modern knowledge concerning the germ-cells and the inner processes of reproduction, it would be idle for us to assert that the seeds which produced these plants had ever been hybridised. They must therefore have been fertilised with their own pollen, or have reproduced themselves by parthenogenesis. After a lengthy correspondence and a careful sifting of the facts, I have come to the conclusion that in eight cases at least out of the eleven, self-fertilisation is quite out of the question, being practically impossible in the circumstances.* There

* See *Jour. Roy. Hort. Soc.* xxi. 1898, p. 477.

seems to remain to us then one reasonable explanation, and that is parthenogenesis.

Parthenogenesis, or the production of fertile seeds in a capsule without fertilisation, is well known to occur in certain plants, *e.g.* Gnaphalium, Mercurialis, and Cœlebogyne.*

Professor Henslow, in his "Structure of Flowers," p. 171, relates how Dr. Treub found a larva of an insect in the ovary of a Mauritian Orchid, Liparis latifolia, which seemed to feed on the juices secreted therein, without injuring either the ovules or the ovary. In a short time, *without the aid of pollen*, the ovules developed and became covered with seed-coats, as if under the influence of pollination; the irritation of the larva seemed to have developed the ovules in the same way the pollen tubes would have done. And this is possibly what has happened with these curious crosses. The pollen tubes of the distinct genera may have irritated and developed the ovules by feeding on the juices secreted by the ovary, yet by some incompatibility failed to fertilise the egg-cells, the result being seed-buds developed within the capsule, naturally bearing the characters of the seed-parent only. [Whether these seed-buds arise direct from the egg-cells, or from the antipodal cells as in cases of polyembryony in Fuchsia, Allium, and Citrus, yet remains to be seen.†] There is, however, one slight difficulty in this explanation which puzzled me for some time, and that is that hitherto it was generally understood that in parthenogenesis all the plants were exactly alike from one capsule, reproducing the varietal characters of the seed-parent down to the minutest detail, just in the same way as ordinary buds and cuttings do; whereas, in the case of the Zygopetalum crosses particularly, the seedlings varied slightly in colour, form, and size, both *inter se*, and from the seed-parent also.

But recent experiments with "Daphnia" have shown that there is a certain amount of variation even in parthenogenetic offspring‡; and as it has been already demonstrated that at least one nuclear division occurs in parthenogenesis,§ this might reasonably have been expected. The one slight difficulty, therefore, in accepting parthenogenesis as the explanation of the above curious crosses seems now to be removed.

The Variation of Primary Hybrids.

Hybrids of the first generation between the same pair of species are found to have a certain specific likeness, yet at the same time they differ one from the other in varietal characters.

Sex, *per se*, does not seem to have any influence in the variation of hybrids in the Orchideæ (owing possibly to their being hermaphrodite by nature), the same varieties occurring both in the reverse and obverse crosses; indeed, in several cases recorded, the progeny of the reverse cross and that of the original one have proved to be exactly the same. As we have seen in the inheritance of varietal characters, when a different variety is used as a parent, the result tends to be different, the variation generally corresponding with that of the variety used. But the variation

* Kerner & Oliver, "Nat. Hist. Plts." ii. p. 469.
† N. H. P. ii. p. 469.
‡ Roy. Soc., 4/5/99, "Nature," 59, p. 142.
§ Weismann's "Germ Plasm," 1893, p. 347.

of first hybrids extends beyond the differences caused by using different varieties as parents, because we often get considerable variation among hybrids raised from the same seed-capsule.

How then is this variation to be explained? A careful analysis of hybrids of Paphiopedilum seems to give a clue to this problem, as the following condensed analyses show. (Compare also those given under the heading of "The Inheritance of Specific Characters.")

(1) (*a*) *Paphiopedilum* × *Lathamianum I.*—A hybrid between P. Spicerianum (Pfitz) and P. villosum (Pfitz), first raised by Mr. Latham, of Birmingham. *In form,* the parent P. Spicerianum is prepotent in the lower sepal and lip, while P. villosum predominates in the leaves; in all, favouring P. Spicerianum as 20 : 15. *In colour,* P. Spicerianum preponderates in the bract and upper sepal, while P. villosum prevails in the scape and lip; altogether favouring P. Spicerianum as 18 : 17. The

FIG. 26. P. SPICERIANUM. FIG. 27. P. × LATHAMIANUM II. FIG. 28. P. VILLOSUM.
Primary Hybrid with its two Parent Species.

whole hybrid, in form and colour, favouring P. Spicerianum as 38 : 32, or 54·2 per cent. (Fig. 19.)

(1) (*b*) *P.* × *Lathamianum II.*—Another variety of the same parentage. *In form,* the parent P. Spicerianum is prepotent in the leaves, lower sepal, and lip; in all favouring that parent as 23 : 17. *In colour,* P. Spicerianum predominates in the upper sepal and staminode, while the other parent, P. villosum, preponderates in the scape and petals. altogether favouring P. villosum as 17 : 15. The whole plant, in form and colour, favouring P. Spicerianum as 38 : 34, or 52·7 per cent. (Fig. 27.)

(1) (*c*) *P.* × *Lathamianum III.*—A third variety of the same parentage. *In form,* P. Spicerianum is prepotent in the scape, while P. villosum predominates in the habit of growth, ovary, lower sepal, and lip; in all favouring P. villosum as 21 : 18. *In colour,* P. Spicerianum pre-

ponderates in the scape, bract, upper sepal, and staminode; while C. villosum prevails in the ovary, petals, and lip; altogether fairly intermediate, as 15 : 15. The whole plant, in form and colour, favouring P. villosum as 36 : 33, or 52·1 per cent.

(2) (*a*) *P.* × *Harrisianum I.*—A hybrid between P. villosum (Pfitz) and P. barbatum (Pfitz) first raised by Messrs. Veitch. *In form,* the parent P. villosum is prepotent in the habit of growth and leaves, while P. barbatum predominates in the staminode; in all, fairly intermediate, as

Fig. 29.—Paphiopedilum × Leeanum superbum.
(P. insigne Chantinii × P. Spicerianum.)

16 : 16. *In colour,* P. villosum preponderates in the upper sepal, while P. barbatum prevails in the leaves, bract, and staminode; altogether favouring P. barbatum as 16 : 13. The whole plant, in form and colour, favouring P. villosum as 32 : 29, or 52·4 per cent.

(2) (*b*) *P.* × *Harrisianum II.*—Another variety of the same parentage. *In form,* P. villosum is prepotent in the habit of growth, while P. barbatum predominates in leaves and staminode; in all, favouring P. barbatum as 17 : 16. *In colour,* P. barbatum prevails in the leaves,

altogether being fairly intermediate, as 15 : 15. The whole plant, in form and colour, favouring P. barbatum as 32 : 31, or 50·7 per cent.

(2) (*c*) *P.* × *Harrisianum III.*—A third variety of the same parentage. *In form,* P. barbatum is prepotent in the habit of growth, leaves, and staminode; in all, favouring that parent as 19 : 16. *In colour,* P. barbatum predominates in the leaves, bract, upper sepal, and staminode; altogether favouring that parent as 17 : 12. The whole plant, in form and colour, favouring P. barbatum as 36 : 28, or 56·2 per cent.

(3) (*a*) *P.* × *Leeanum giganteum.*—A hybrid out of P. Spicerianum (Pfitz) by P. insigne (Pfitz), var. giganteum, raised by Messrs. Heath, of Cheltenham. *In form,* the parent P. Spicerianum is prepotent in the leaves and upper sepal, while P. insigne predominates in the petals; in all, airly intermediate as 17 : 17. *In colour,* P. Spicerianum preponderates

FIG. 30. P. INSIGNE CHANTINII. | FIG. 31. P. × NITENS I. | FIG. 32. P. VILLOSUM.

Primary Hybrid with its two Parent Species.

in the upper sepal and petals, altogether favouring that parent as 18 : 15. The whole plant, in form and colour, favouring P. Spicerianum as 35 : 32, or 52·2 per cent.

(3) (*b*) *P.* × *Leeanum superbum.*—A hybrid of the same specific parentage, raised by Mr. Chas. Winn, of Birmingham; but in this case P. insigne Chantinii was the parental variety. *In form,* P. Spicerianum is prepotent in the upper sepal, lower sepal, and petals, while P. insigne predominates in the habit of growth, leaves, lip, and staminode; in all, favouring P. insigne as 22 : 17. *In colour,* P. Spicerianum preponderates in the upper sepal, while P. insigne prevails in the lower sepal and staminode; altogether favouring P. Spicerianum as 17 : 16. The whole plant, in form and colour, favouring P. insigne as 38 : 34, or 52·7 per cent. (Fig. 29.)

(3) (*c*) P. × *Leeanum Albertianum.*—A hybrid of the same specific

parentage, raised by M. Jules Hye-Leysen, of Ghent, the parental variety used being P. insigne Wallacei. *In form,* P. Spicerianum is prepotent in the habit of growth; in all, favouring that parent as 24 : 23. *In colour,* P. Spicerianum predominates in the leaves, while P. insigne preponderates in the lower sepal and lip; altogether favouring P. insigne as 17 : 16. The whole plant, in form and colour, being fairly intermediate, as 40 : 40, or 50 per cent. of each parent.

(4) (*a*) P. × *nitens I.*—A hybrid out of P. villosum (Pfitz) by P. insigne (Pfitz), var. Maulei, raised by Messrs. Veitch. *In form,* the parent P. insigne is prepotent in the ovary and lip; in all, favouring that parent as 23 : 19. *In colour,* P. insigne predominates in the upper sepal, lower sepal, and staminode, while P. villosum preponderates in the leaves; altogether favouring P. insigne as 18 : 14. The whole plant, in form and colour, favouring P. insigne as 42 : 32, or 56·7 per cent. (Fig. 31.)

(4) (*b*) *P.* × *nitens II.*—A second variety of the same parentage, received by me from Mr. Winn, of Birmingham. *In form,* P. insigne is prepotent in the ovary and lip; in all, favouring that parent as 23 : 19. *In colour,* P. insigne predominates in the upper sepal, lower sepal, and staminode; altogether favouring that parent as 18 : 12. The whole plant, in form and colour, favouring P. insigne as 41 : 31, or 56·9 per cent.

(4) (*c*) *P.* × *nitens III.*—A third variety of the same parentage, received by me from Mr. Reginald Young, of Liverpool, and known as *var. giganteum. In form,* P. insigne is prepotent in the ovary and upper sepal, while P. villosum predominates in the habit of growth and leaves; in all, favouring P. villosum as 20 : 19. *In colour,* P. insigne predominates in the upper sepal and lower sepal, while P. villosum prevails in the ovary; altogether favouring P. insigne as 16 : 12. The whole plant, in form and colour, favouring P. insigne as 35 : 32, or 52·2 per cent.

(4) (*d*) *P.* × *nitens IV.*—A fourth variety of the same parentage, raised by Messrs. Veitch, and known generally as *var. superbum. In form,* P. insigne is prepotent in habit of growth, ovary, and upper sepal; in all, favouring that parent as 25 : 18. *In colour,* P. insigne predominates in the leaves, upper sepal, and staminode; altogether favouring that parent as 19 : 13. The whole plant, in form and colour, favouring P. insigne as 44 : 31, or 58·6 per cent.

(4) (*e*) *P.* × *nitens Sallierii,* really the typical hybrid from typical forms of both parents, and received by me from Mr. Reginald Young, of Liverpool. *In form,* P. villosum is prepotent in the petals; in all, favouring that parent as 22 : 20. *In colour,* P. insigne predominates in the leaves, upper sepal, and lower sepal, while P. villosum preponderates in the petals; altogether favouring P. insigne as 19 : 15. The whole plant, in form and colour, favouring P. insigne as 39 : 37, or 51·3 per cent.

These hybrids, as a whole, are fairly intermediate between their two parents, yet there is in most cases a local predominance of one parent or the other in one part or another of the hybrid. This applies equally either to form or colour.

When several hybrids from the same pair of species are compared together, this variation of the parts, or "Partial Prepotency," as I propose to call it, becomes even more apparent and more diverse. For example, in

three hybrids raised from the same parents, in the first, the pollen-parent may predominate in form in a certain part; in the second, the seed-parent may prevail in that part; while in the third, that part may be fairly intermediate between both parents; while in regard to colour, these conditions may be exactly reversed. But this only includes one part of the hybrid, and the same law applies equally to every one of the parts; so that when the changes are rung on twenty or more different parts by the two parents, in both form and colour, we can well understand the many possibilities of variation in hybrids of the same parentage; and I venture to suggest that this law of Partial Prepotency, founded on actual facts observed in hybrids of Paphiopedilum, may perhaps throw some light on the question of variation in offspring of the same parents. Yet, notwithstanding this variation in the parts, it is a remarkable fact that in primary hybrids the whole plant taken together is fairly intermediate between the two parents, the balance of power being well maintained in the whole.

The greatest extreme observed by me, out of many cases in Paphiopedilum, has been 58·6 per cent. of one parent, against 42·4 per cent. of the other, the great majority being approximately 50 per cent. of each parent. This hardly coincides with the popular belief that some hybrids resemble one parent, while others resemble the other; but this may be due simply to superficial observation, for where conspicuous parts lean towards one parent, the casual observer might easily be deceived, not noticing the inconspicuous parts which compensate for this by leaning towards the other parent.

The Variation of Secondary Hybrids.

Hybrids of the second generation, whether of two, three, or four species, differ notably from hybrids of the first generation of two species by reason of their much wider range of variation. Whether this be due simply to the increased factors in their pedigree, or whether apart from that, I have not yet been able to gather sufficient evidence to determine; still, the fact remains that, from whatever cause, hybrids of the second generation are far more variable than those of the first generation. As an illustration of this I will take two sets of hybrids in Paphiopedilum, in one of which we will consider the colour of the flowers, and in the other the habit, form, and colour of the leaves. Both groups are hybrids of the second generation, from three distinct species (*i.e.* a hybrid of two species crossed with a third species), and in both the law of Partial Prepotency is remarkably evident. The first of the two sets was raised by M. Jules Hye-Leysen, of Ghent, between varieties of P. Spicerianum (Pfitz) and P. × nitens, the latter parent being itself a hybrid between P. insigne (Pfitz) and P. villosum (Pfitz). Some twenty-two hybrids have already flowered, many of them having been raised out of the same seed-capsule. Each of these hybrids has received a distinct name, and perhaps worthily so, from their wide variation and distinctness; but for the sake of convenience I will allude to them as varieties of the original one, viz. P. × aureum. The following diagram will show their pedigree at a glance:—

DIAGRAM SHOWING THE TWO PARENTS AND FOUR GRANDPARENTS OF PAPHIOPEDILUM × AUREUM (vars.).

P. S.	P. S.	P. insigne	P. villosum
P. Spicerianum		P × nitens	

PAPHIOPEDILUM × AUREUM (vars.).

According to the Galtonian law of Ancestral Heredity, these varieties should, *on the average*, show $\frac{1}{2}$ P. Spicerianum + $\frac{1}{4}$ P. × nitens + $\frac{1}{8}$ P. insigne + $\frac{1}{8}$ P. villosum; or to put it more simply, $\frac{1}{2}$ P. Spicerianum + $\frac{1}{4}$ P. insigne + $\frac{1}{4}$ P. villosum.

The following facts will show how, in regard to the colours of the different parts of the flowers, the Galtonian law seems to be disturbed by Partial Prepotency :—

Colour of Flowers (comprising Upper Sepal, Lower Sepal, Petals, Lip, and Staminode).

(1) *P.* × *aureum.*—The parent P. Spicerianum is prepotent in the staminode, while the grandparent P. insigne predominates in the upper and lower sepals.

(2) *P.* × *a. Hebe.*—The parent P. Spicerianum and the grandparent P. insigne together predominate in all parts of the flower, viz. upper sepal, lower sepal, petals, lip, and staminode; indeed this variety might, at first sight, pass as a form of P. × Leeanum (P. Spicerianum × P. insigne), but a careful examination reveals the influence of P. villosum, especially in the shape and general habit of the flower.

(3) *P.* × *a. Surprise.*—The whole flower in colour resembles a greenish form of P. insigne Sanderæ, the spots of P. insigne and the ruby band of P. Spicerianum being quite obliterated in the upper sepal; yet, in form and a few minor details, its full parentage may be traced.

(4) *P.* × *a. virginalis.*—The parent P. Spicerianum predominates in the upper sepal and staminode, while P. villosum preponderates in the petals and lip. This variety would almost pass for a compact form of P. × Lathamianum (P. Spicerianum × P. villosum), but differs again in minor details, confirming its parentage.

(5) *P.* × *a. Augusta.*—The parent P. Spicerianum and the grandparent P. insigne together predominate in the upper sepal, while P. Spicerianum alone preponderates in the staminode.

(6) *P.* × *a. Eteocle.*—The parent P. Spicerianum predominates in the upper sepal, the grandparent P. villosum in the petals, while P. Spicerianum and P. insigne together preponderate in the staminode.

(7) *P.* × *a. Hermione.*—The parent P. Spicerianum predominates in the upper sepal, P. insigne and P. villosum together preponderate in the petals, while P. Spicerianum and P. insigne prevail in the staminode.

(8) *P.* × *a. Hermode.*—The parent P. Spicerianum and the grand-

parent P. insigne together predominate in the upper sepal, lower sepal, and staminode.

(9) *P.* × *a. Hero.*—P. Spicerianum and P. insigne together predominate in the upper sepal and staminode; while P. Spicerianum and P. villosum preponderate in the petals.

(10) *P.* × *a. Minos.*—P. Spicerianum and P. insigne together predominate in the staminode, P. insigne alone preponderates in the upper and lower sepals, and P. villosum alone in the petals.

(11) *P.* × *a. Œdipe.*—P. Spicerianum and P. insigne together predominate in the upper sepal and staminode, while P. villosum alone prevails in the petals.

(12) *P.* × *a. Olympia.*—P. Spicerianum and P. insigne together predominate in the upper sepal and staminode, while P. insigne alone prevails in the petals.

(13) *P.* × *a. Osiris.*—P. Spicerianum predominates in the upper and lower sepals; P. villosum alone preponderates in the petals, and P. insigne alone in the staminode.

(14) *P.* × *a. Polynice.*—P. Spicerianum and P. insigne together predominate in the upper sepal, P. insigne and P. villosum in the lower sepal, and P. Spicerianum alone in the staminode.

(15) *P.* × *a. Pomone.*—P. insigne predominates alone in the upper sepal, P. insigne and P. villosum together in the petals, and P. Spicerianum and P. villosum in the staminode.

(16) *P.* × *a. Vertumne.*—P. Spicerianum and P. insigne together predominate in the upper sepal and staminode, while P. villosum alone prevails in the petals.

(17) *P.* × *a. amœna.*—P. Spicerianum and P. insigne together predominate in the upper sepal, P. insigne alone in the lower sepal, and P. Spicerianum alone in the petals and staminode.

(18) *P.* × *a. Cyrus.*—P. insigne alone predominates in the upper sepal; P. insigne and P. villosum together preponderate in the petals; and P. Spicerianum and P. villosum prevail in the staminode.

(19) *P.* × *a. delicatulum.*—P. Spicerianum alone predominates in the upper sepal; P. insigne and P. villosum together preponderate in the petals; and P. Spicerianum and P. insigne together prevail in the staminode.

(20) *P.* × *a. Mellona.*—P. Spicerianum and P. insigne together predominate in the upper sepal and staminode; P. insigne alone preponderates in the lower sepal; while P. insigne and P. villosum together prevail in the petals.

(21) *P.* × *a. Micias.*—P. insigne alone predominates in the upper sepal; while P. insigne and P. villosum together preponderate in the petals, and P. Spicerianum and P. villosum together in the staminode.

(22) *P.* × *a. tigrinum.*—P. Spicerianum and P. insigne together predominate in the upper sepal; P. insigne alone preponderates in the lower sepal; P. Spicerianum alone in the petals; while P. Spicerianum and P. villosum together prevail in the staminode.

Apart from the above prepotencies the parts of these twenty-two hybrids are fairly intermediate in colour between the three ancestral

species. The second set of hybrids to illustrate the variability of secondary hybrids and the law of Partial Prepotency consist of twenty-four plants, all raised from the same seed-capsule by Mr. Reginald Young, of Liverpool, out of P. Boxalli (Pfitz), var. atratum, by P. × politum, the latter being itself a hybrid between P. barbatum and P. venustum. (Figs. 33–38.) For the sake of convenience I will class these unflowered hybrids as forms of what I believe to be the original hybrid of the same parentage, viz. P. × Pluto, raised by Messrs. Low, of Bush Hill Park, using Roman numerals from I. to XXIV. to distinguish the individual varieties.

The following diagram will show the pedigree at a glance :—

Diagram showing the Two Parents and Four Grandparents of Paphiopedilum × Pluto (vars.).

P. B. ♂ Fig. 35.	P. B. ♀ Fig. 36.	P. barbatum Fig. 37.	P. venustum Fig. 38.
P. Boxalli atratum ♂ Fig. 33.		P. × politum ♀ Fig. 34.	

Paphiopedilum × Pluto (vars.).

According to the Galtonian law, these varieties of the hybrid P. × Pluto should show, on the average, $\frac{1}{2}$ P. Boxalli + $\frac{1}{4}$ P. × politum + $\frac{1}{8}$ P. barbatum + $\frac{1}{8}$ P. venustum ; or to put it more simply, $\frac{1}{2}$ P. Boxalli + $\frac{1}{4}$ P. barbatum + $\frac{1}{4}$ P. venustum.

The following facts will show the disturbing factor of Partial Prepotency in regard to the habit, form, and colour of the leaves.

Prepotencies in Habit, Form, and Colour of Leaves.

P. × Pluto, I.—The parent P. Boxalli is prepotent in habit and form, while the grandparent P. venustum predominates in colour of leaves.

P. × Pluto, II.—The grandparent P. venustum predominates in colour of leaves.

P. × Pluto, III.—P. Boxalli alone predominates in habit, while P. Boxalli and P. venustum together preponderate in colour of leaves.

P. × Pluto, IV.—P. Boxalli alone predominates in habit, while P. Boxalli and P. barbatum together preponderate in colour of leaves.

P. × Pluto, V.—P. Boxalli predominates in form, while P. venustum preponderates in habit and colour of leaves.

P. × Pluto, VI.—P. Boxalli predominates in habit, while P. venustum preponderates in colour of leaves.

P. × Pluto, VII.—P. Boxalli predominates in habit and colour, while P. barbatum prevails in form of leaves.

P. × Pluto, VIII.—P. Boxalli alone predominates in habit and form, while P. barbatum and P. venustum together preponderate in colour of leaves.

P. × *Pluto*, *IX.*—P. Boxalli and P. venustum together predominate in habit, while P. Boxalli and P. barbatum together preponderate in colour of leaves.

P. × *Pluto*, *X.*—P. Boxalli and P. venustum together predominate in habit, while P. Boxalli and P. barbatum together preponderate in form of leaves.

P. × *Pluto*, *XI.*—The grandparent P. barbatum alone predominates in form, while the grandparents P. barbatum and P. venustum together preponderate in colour of leaves.

P. × *Pluto*, *XII.*—P. Boxalli alone predominates in habit and form, while P. Boxalli and P. venustum together preponderate in colour of leaves.

P. × *Pluto*, *XIII.*—P. barbatum alone predominates in form, P.

Fig. 35. P. Boxalli. Fig. 36. P. Boxalli. Fig. 37. P. barbatum. Fig. 38. P. venustum.

Fig. 33.—P. Boxalli atratum. Fig. 34.—P. × politum.
Two Parents and four Grandparents of Paphiopedilum × Pluto vars. I.–XXIV.

venustum in habit, while P. Boxalli and P. venustum together prevail in colour of leaves.

P. × *Pluto*, *XIV.*—P. Boxalli and P. barbatum together predominate in habit, form, and colour of leaves.

P. × *Pluto*, *XV.*—P. Boxalli and P. barbatum together predominate in habit and colour, while P. Boxalli and P. venustum together preponderate in form of leaves.

P. × *Pluto*, *XVI.*—P. barbatum alone predominates in habit, while P. Boxalli and P. barbatum together preponderate in form and colour of leaves.

P. × *Pluto*, *XVII.*—P. Boxalli alone predominates in habit; P. Box-

alli and P. barbatum together preponderate in form; and P. Boxalli and P. venustum together prevail in colour of leaves.

P. × *Pluto, XVIII.*—P. venustum alone predominates in habit; P. barbatum alone preponderates in form; while P. Boxalli and P. venustum together prevail in colour of leaves.

P. × *Pluto, XIX.*—P. barbatum alone predominates in habit, while P. Boxalli and P. barbatum together preponderate in form and colour of leaves.

P. × *Pluto, XX.*—P. Boxalli and P. venustum together predominate in habit and form of leaves.

P. × *Pluto, XXI.*—P. Boxalli and P. barbatum together predominate in habit, while P. Boxalli alone prevails in form and colour of leaves.

P. × *Pluto, XXII.*—P. barbatum alone predominates in habit and form, while P. Boxalli and P. barbatum together preponderate in colour of leaves.

P. × *Pluto, XXIII.*—P. Boxalli and P. venustum together predominate in habit; P. barbatum alone preponderates in form; and P. Boxalli alone in colour of leaves.

FIG. 39.—PAPHIOPEDILUM × PLUTO VARS. I.–XXIV.
(P. BOXALLI ATRATUM ♀ × P. × POLITUM ♂.)

P. × *Pluto, XXIV.*—P. venustum alone predominates in habit; P. barbatum alone preponderates in form; while P. barbatum and P. venustum together prevail in colour of leaves.

All the hybrids, without exception, show distinct traces of both the parental and ancestral species, but in different proportions. Certain individual parts of some of the hybrids are fairly well balanced between their three pedigree species; in other parts one or other of the three species clearly predominates; while in other parts, again, any two of the three species prevail; and so on through all the variations, the changes being rung on the different parts by the three pedigree species, both in form and colour, giving rise to numerous variations. Indeed, in the one case detailed above, out of twenty-four hybrids raised from the

same seed-capsule, no two are alike, and yet all show distinct traces of their ancestry, and well illustrate the law of Partial Prepotency.

One point may be noted here that comes out clearly in an examination of the above hybrids, and that is the latency of certain characters in the first generation which come out markedly in the second generation.

The hybrid parent of these twenty-four hybrids, P. × politum, fails to show the colour characters of one of its own parents, P. barbatum, in the leaves; yet in a number of cases these same colour characters reappear strongly in the second generation, clearly showing that certain characters may remain latent in one generation to reappear in the next.

The Fertility of Hybrids.

The question of the fertility of hybrids is very important both to the student and to the practical breeder. If a hybrid, *i.e.* a first cross between two distinct species, be not fertile, its further improvement by crossing is obviously barred; but if it prove fertile in however small a degree, then in the hands of the skilled hybridist it may prove to be the starting-point of a series of variations of great economic value.

Amid the many misconceptions concerning hybrids in the popular mind perhaps none has clung so tenaciously as the belief in their absolute infertility. In studying the records of our foremost hybridists—Kolreüter, Gartner, Herbert, Darwin, Kerner, Naudin, and Dr. Focke—one is impressed at once with the undoubted fertility of many hybrids, and I have compiled a list of genera from these authorities, and from my own observations, in which fertile hybrids are known. I find that no less than ninety distinct genera are recorded in which fertile hybrids are known, and only four in which the hybrids are all quite infertile.

This list is doubtless incomplete, yet it may possibly serve a useful purpose in demonstrating the undoubted fertility of many hybrids, and the rare absolute infertility of others.

In the natural order Compositæ we have fertile hybrids in Cirsium, Inula, Chrysanthemum, Senecio, Hieracium, Lactuca, and Tragopogon.

In Rosaceæ we have Prunus, Pyrus, Fragaria, Geum, Rosa, Rubus, and Cratægus.

In Ranunculaceæ: Anemone, Aquilegia, and Clematis.

In Gesneraceæ: Achimenes, Streptocarpus, Isoloma, and Gloxinia.

In Carophylleæ: Silene, Lychnis, Melandrium, and Dianthus.

In Liliaceæ: Scilla, Chionodoxa, and Chionoscilla.

In Solanaceæ: Solanum, Datura, Nicotiana, and Petunia.

In Scrophularineæ: Calceolaria, Veronica, Verbascum, and Linaria.

In Amaryllideæ: Hippeastrum, Crinum, Narcissus.

In Campanulaceæ: Campanula and Lobelia.

In Geraniaceæ: Pelargonium and Ciconium.

In Ericaceæ: Rhododendron and Erica.

In Cucurbitaceæ: Cucumis and Cucurbita.

In Onagrarieæ: Œnothera and Epilobium.

In Gramineæ: Triticum and Ægilops.

In Leguminosæ: Cytisus, Medicago, Pisum, and Phaseolus.

In Malvaceæ: Abutilon and Lavatera.

In Orchideæ: Paphiopedilum, Phragmipedilum, Calanthe, Cattleya,

Dendrobium, Disa, Epidendrum, Lælia, Lælio-Cattleya, Masdevallia, Phalænopsis, Odontoglossum, Thunia, and Chysis.

While in other natural orders we have fertile hybrids in Cotyledon, Begonia, Quercus, Gladiolus, Vitis, Cereus, Viola, Canna, Brassica, Nymphæa, Primula, Lamium, Æsculus, Berberis, Mirabilis, Salix, Mentha, Passiflora, and Fuchsia.

On the other hand, we have those genera whose hybrids, so far as experiments have yet been made, are all absolutely infertile. After a careful search I have only been able to find four of these—namely, Ribes, Polemonium, Digitalis, and Papaver—and in none of these have many experiments been made.

To my mind, negative results, though useful in their way, are never safe guides to follow. I have observed many cases in the Orchideæ where again and again certain species have refused to cross, yet at another time, and under other conditions, quite unexpectedly have produced fertile seeds; and I think that one may reasonably expect even these four recalcitrant genera to produce fertile hybrids in the course of time.*

In regard to the ninety genera which have produced fertile hybrids, it may possibly be argued that many of them are not true hybrids, because they have been raised from closely related species; but even if this be granted, what about the numerous fertile hybrids from very distinct species? For instance, the species of Lælia (Lindl.) and Cattleya (Lindl.) respectively are still classed as distinct *genera* by our best botanists; and I think that the most easy-going systematist would admit them to be distinct *species*, yet hybrids raised between these two genera are very fertile.

But perhaps the best practical proof of the fertility of hybrids is the numerous hybrids raised in gardens, of many generations, from several species.

(1) For instance, fertile hybrids have been raised by Messrs. Sutton & Sons, of Reading, between Solanum tuberosum and S. Maglia, forty-one seedlings being raised from two hybrid plants of the first generation.

(2) Cytisus × præcox, a hybrid between C. albus and C. purgans, seeds freely in my garden, and many plants have been raised in nurseries; these are the second generation of two species.

(3) As mentioned in another part of this paper, I have raised 500 plants from seeds of Berberis × stenophylla, itself a hybrid between the two species B. Darwinii and B. empetrifolia.

(4) Mr. James has raised a large batch of seedlings from five hybrid Senecios, themselves the product of S. cruentus and S. Heritieri.

(5) Scilla bifolia and Chionodoxa Luciliæ cross naturally in gardens, and their hybrids, Chionoscilla × Alleni, seed very freely.

(6) Some of the best forms of Narcissus in gardens are the result of hybrids between N. poeticus and N. obvallaris, recrossed with one or other of the parent species.

(7) Our fine garden Strawberries of the present day have been raised from many generations, of two species at least, viz. Fragaria virginiana and F. chiloensis, and probably in some cases, such as the variety 'St. Joseph,' from F. vesca alpina.

* Since the above paper was written, M. Vilmorin, of Paris, tells us that he has succeeded in obtaining fertile hybrids in Papaver.

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(8) Hybrids between Aquilegia californica and A. chrysantha, and A. cærulea and A. chrysantha crossed *inter se*, by Mr. James Douglas, yielded an extraordinary variety of forms, being several generations of three species.

(9) The new race of Streptocarpus, raised at Kew, are from the intercrossing of hybrids between the three species, S. Dunni, S. Rexi, and S. parviflorus.

(10) Our garden Roses are the product of the hybridisation through many generations of at least three species, viz. R. gallica, R. indica, and R. multiflora; while Lord Penzance has raised hybrids between R. lutea and R. rubiginosa which are fertile, both self-crossed, and also with the race of Hybrid Perpetuals, raised originally from R. gallica and R. indica. Here we have hybrids of four distinct species.

(11) The Amaryllis or Hippeastrum of gardens have been derived from hybrids of many generations, of several species.

(12) Gladiolus × Nanceianus is a hybrid of the third generation, uniting the four species G. psittacinus, G. oppositiflorus, G. Saundersi, and G. purpurato-auratus.

(13) The Orchid-flowering Cannas 'Italia,' 'Austria,' 'Burbank,' &c., are the third generation of four species, namely C. iridiflora, C. Warscewiczii, C. glauca, and C. flaccida.

(14) In Paphiopedilum (Pfitz) (known in gardens as Cypripedium), twenty-eight hybrids have been recorded, each combining in its pedigree four distinct species.*

(15) Rhododendron 'Eos,' raised by Mr. Heale, for Messrs. Veitch, of Chelsea, is a hybrid of the fourth generation, of four distinct species, viz. R. javanicum, R. jasminiflorum, R. Lobbii, and R. Malayanum; while R. 'Numa,' raised by the same firm, is a hybrid of the fifth generation, and contains the five following species:—R. javanicum, R. jasminiflorum, R. Brookianum racile, R. indicum (Azalea indica Stella), and R. multicolor Curtisii. (Figs. 40 and 41.)

But there is another phase of the question, which is of some importance, and that is the diminished fertility of some hybrids as compared with the fertility of natural species, and it is here probably that the popular idea of the infertility of hybrids first arose. Darwin, who made a most elaborate survey of the whole question, used the word "sterility," not in the general sense of barrenness, *i.e.* absolute infertility, but simply in the sense of diminished fertility, standing as it were midway between complete fertility and absolute infertility; so that when he wrote of the "sterility of hybrids," he simply meant their lessened fertility, and not their infertility as most people seemed to imagine. Darwin, after careful research and many experiments, came to the following conclusion upon the whole matter, that "the sterility of distinct species when first united, and that of their hybrid offspring, graduates by an almost infinite number of steps from zero (when the ovule is never impregnated and a seed-capsule is never formed) up to complete fertility."† This general statement is as true to-day as it was then. Darwin then goes on to say that ". . . this high degree of fertility is, however, rare." Recent

* See *Orch. Rev.* iv. p. 361.

† *Animals and Plants*, 2nd ed. ii. p. 163.

experiments have demonstrated that this high degree of fertility is no longer rare, so that Darwin's sentence, "This high degree of fertility is, however, rare," might now read, "This high degree of sterility is, however, rare."

Some statistics I prepared some time ago,* and now made up to date, serve as an illustration of this from the Orchideæ. During the past seven years Mr. Reginald Young, of Liverpool, the well-known orchidist, has been crossing *inter se* some 30 distinct species and 53 distinct hybrids in the genus Paphiopedilum (Pfitz), and has kindly placed his stud book at my disposal, in which are precisely and carefully recorded no less than 849 crosses. Of these, taken together, 80·2 % have proved fertile, *i.e.* produced good seeds. Of 263 crosses between distinct species 95·0 % were fertile. This seems to show that in this genus crosses between distinct species are almost, if not quite, as fertile as crosses between varieties of the same species (taking the latter at complete fertility, *i.e.* 100%); while in crosses in which a hybrid was concerned in the parentage, out of 586, only 73·5 % proved fertile, showing that crosses with hybrids, though fertile to a high degree, are yet rather less fertile than crosses between species.

A further analysis of the figures shows that while hybrids crossed with the pollen of pure species give 91·8 % fertile, yet pure species crossed with the pollen of hybrids give but 60 % fertile. This seems to point to the conclusion that the slight decline in the fertility of hybrids is due in a large measure to the loss of power in the pollen of hybrids.

This decline of power in the male element of hybrids is very curious, but has been observed before in other plants by Darwin, Dr. Focke, Dr. Maxwell Masters, and Prof. Macfarlane, and also by Prof. Ewart in his Zebra hybrids. Practical breeders will therefore be wise, in crossing hybrids with species, to always use the pollen of species in preference to that of hybrids.

It is quite possible that domestication or cultivation may in time eradicate this decline in the fertility of hybrids, for I observe that in my hybrid Berberis × stenophylla, the first hybrids between the two wild species flower more profusely, but bear fewer berries than the parent species; while the hybrids of the second generation are much more profuse in their berry-bearing, being apparently more fruitful even than the wild species. It very often happens that the pollen of very young hybrids is not so effective as that of those of more mature growth. Mr. Reginald Young believes this to be so with his Paphiopedilums; and Dr. Focke records a case of a hybrid Sinningia in which the pollen of the second year of flowering was better than that of the first. The decline of fertility is by no means confined to hybrids alone; for instance, certain races of Primula sinensis raised by Messrs. Sutton, of Reading, have proved difficult to perpetuate owing to their diminished fertility, and these are cross-breds, not hybrids, being raised within the limits of one species.

In the face of these facts, therefore, we must conclude that fertility depends more upon the conditions of life than upon hybridism, and there is no reason why hybrids should not in time become as fully fertile as cross-breds usually are.

* See *Jour. Roy. Hort. Soc.* xxi. [April, 1898], p. 485

THE STABILITY OF HYBRIDS.

Next to the question of the fertility of hybrids, perhaps the most important to the practical breeder is the constancy or stability of hybrids fertilised with their own pollen. If, as is generally supposed, hybrids do not breed true to themselves, but are inconstant and tend to revert to their grandparent species, then is the breeder's work vain, and the economic importance of hybrids considerably diminished. With a view to ascertain more precise facts than are at present on record in regard to this question, I have carried out some experiments in the genus Berberis, raising a large batch of B. × stenophylla from self-fertilised seed.

Berberis × stenophylla is a primary hybrid between B. Darwinii and B. empetrifolia, originally raised by Messrs. Fisher & Holmes, of Handsworth, Sheffield.

The two parent species are very distinct. The one (B. Darwinii) has a vigorous and upright habit of growth, while the other (B. empetrifolia) i weak and drooping in habit. In the one the stems are thick, much branched, and covered with short, woolly, brown hairs; while the other has slender stems, little branched, and quite glabrous. In the one the spines are seven in number—short, spreading, and flat—while in the other they are three (one long and two short), set like an inverted T, each rounded and grooved below. In the one the leaves number three to four, broad, flat; with five to seven spiny teeth, shiny green above, lighter below; while in the other the leaves are seven to nine, linear, closely revolute, erect, sharply mucronate, dull, dark green above, silvery below. In the one the flowers are racemose, six to twelve, orange-yellow, shaded with red without, pedicels rich red, flower segments long and narrow; while in the other, the flowers are single or sub-umbellate golden yellow, on slender green pedicels, segments short and broad.

The hybrid B. × stenophylla is intermediate in most characters between the two parent species. Its habit of growth is very vigorous, first upright and then drooping gracefully; stems medium thickness, branches long, pendent, slightly pubescent, with three spines of equal size. Leaves variable, four to nine, narrow, partly revolute, sub-erect, mucronate, dark green above, silvery green below. Flowers, sub-umbellate, one to six, deep yellow, pedicels reddish, segments intermediate. Altogether the hybrid is fairly intermediate, though B. empetrifolia is prepotent in the number and habit of the spines; in all, favouring that parent as 13 : 12, or 52 per cent. Five hundred seedlings of this hybrid were raised, and of these no less than 90 per cent. reproduced the characters of the parent hybrid faithfully and well, with little variation; while the remaining 10 per cent. varied from a form representing about 66 per cent. of the grandparent B. empetrifolia, through a series of intermediate forms up to an extreme one, which reproduced about 67 per cent. of the characters of the grandparent B. Darwinii. It is worthy of notice that not one plant out of the 500 *completely* reverted to either of the ancestral species, No. 18 being the nearest to B. Darwinii, and No. 1 the nearest to B. empetrifolia.

The following condensed analysis of thirty of the most variable of these secondary hybrids will show at a glance how they differ from one

another, and how far they seem to have reverted towards their grand-parents. Indirectly, too, they serve to illustrate once more the law of Partial Prepotency.

Berberis × *stenophylla vars.* 1 *to* 30.

h=habit, f=form, c=colour.

(1) B. empetrifolia is prepotent in h and f of stems, h, f, and c of spines, in h, f, and c of leaves, and in h, f, and c of flowers. In all, favouring that ancestor as 23 : 12, or 65·7 per cent. This form is the nearest reversion to B. empetrifolia in the whole batch, but traces of B. Darwinii still remain in all the parts, especially in the colour of the stems.

(2) B. empetrifolia is prepotent in h and f of stems, in h of spines, in h, f, and c of leaves, and in h of flowers. Altogether favouring that ancestor as 19 : 12, or 61·2 per cent.

(3) B. empetrifolia is prepotent in h, f, and c of stems, in h of spines, and in c of leaves; in all, favouring that ancestor as 17 : 12, or 58·6 per cent.

(4) B. Darwinii is prepotent in h, f, and c of stems, in h, f, and c of spines, in f of leaves, and in h, f, and c of flowers; altogether favouring that ancestor as 22 : 12, or 64·7 per cent.

(5) B. Darwinii is prepotent in c of stems, and in h, f, and c of flowers, while B. empetrifolia predominates in h of spines and in h and c of leaves; in all, favouring B. Darwinii as 16 : 15, or 51·6 per cent.

(6) B. empetrifolia is prepotent in h, f, and c of stems, in h and c of spines, and in h, f, and c of leaves; altogether favouring that ancestor as 20 : 12, or 62·5 per cent.

(7) B. Darwinii is prepotent in f and c of stems, in f and c of leaves, and in h, f, and c of flowers, while B. empetrifolia predominates in h of leaves; in all, favouring B. Darwinii as 19 : 13, or 59·3 per cent.

(8) B. empetrifolia is prepotent in f and c of stems, in h and c of spines, in h, f, and c of leaves, and in h and f of flowers, while B. Darwinii predominates in c of flowers; in all, favouring B. empetrifolia as 21 : 13, or 61·7 per cent.

(9) B. empetrifolia is prepotent in f of stems, in h and c of spines, in h, f, and c of leaves, and in h of flowers, while B. Darwinii predominates in f and c of flowers; in all, favouring B. empetrifolia as 19 : 14, or 57·5 per cent.

(10) B. Darwinii is prepotent in f of stems, in f of leaves, and in f and c of flowers, while B. empetrifolia predominates in c of leaves; in all, favouring B. Darwinii as 16 : 13, or 55·1 per cent.

(11) B. empetrifolia is prepotent in h of stems, in h, f, and c of spines, and in f of leaves, while B. Darwinii predominates in f of stems, in c of leaves, and in h of flowers; in all, favouring B. empetrifolia as 17 : 15, or 53·1 per cent.

(12) B. empetrifolia is prepotent in f of stems, in h and c of spines, in f and c of leaves, and in h of flowers, while B. Darwinii predominates in h of leaves; in all, favouring B. empetrifolia as 18 : 13, or 58·0 per cent.

(13) B. empetrifolia is prepotent in h, f, and c of spines, in h, f, and c

of leaves, and in h and f of flowers; altogether favouring that ancestor as 20 : 12, or 62·5 per cent.

(14) B. empetrifolia is prepotent in h of spines and in h, f, and c, of leaves, while B. Darwinii predominates in f and c of flowers; in all, favouring B. empetrifolia as 16 : 14, or 53·3 per cent.

(15) B. Darwinii is prepotent in f and c of spines and in h, f, and c of leaves, while B. empetrifolia predominates in f and c of stems and in f of flowers; in all, favouring B. Darwinii as 17 : 15, or 53·1 per cent.

(16) B. empetrifolia is prepotent in h and f of stems, in c of spines, and in f and c of leaves, while B. Darwinii predominates in f of spines, in h of leaves, and in f and c of flowers; in all, favouring B. empetrifolia as 17 : 16, or 51·5 per cent.

(17) B. Darwinii is prepotent in f and c of stems, in f of spines, in h and f of leaves, and in h and c of flowers, while B. empetrifolia predominates in h of spines, in c of leaves, and in f of flowers; in all, favouring B. Darwinii as 19 : 15, or 55·8 per cent.

(18) B. Darwinii is prepotent all round in h, f, and c of stems, spines, leaves, and flowers, yet distinct traces of B. empetrifolia are to be found in all the parts. This form is the nearest reversion to the grandparent B. Darwinii in the whole batch, favouring that ancestor as 24 : 12, or 66·6 per cent.

(19) B. Darwinii is prepotent in h, f, and c of stems, in h, f, and c of spines, in f and c of leaves, and in h and c of flowers, while B. empetrifolia predominates in h of leaves and in f of flowers; in all, favouring B. Darwinii as 22 : 14, or 61·1 per cent.

(20) B. empetrifolia is prepotent in c of stems, in h of spines, and in h, f, and c of leaves; altogether favouring that ancestor as 17 : 12, or 58·6 per cent.

(21) B. empetrifolia is prepotent in f of stems, in h, f, and c of spines, in h, f, and c of leaves, and in h of flowers; altogether favouring that ancestor as 20 : 12, or 62·5 per cent.

(22) B. empetrifolia is prepotent in h and f of stems, in h of spines, in h, f, and c of leaves, and in h of flowers, while B. Darwinii predominates in c of stems; in all, favouring B. empetrifolia as 19 : 13, or 59·3 per cent.

(23) B. Darwinii is prepotent in c of stems and in f of leaves; while B. empetrifolia predominates in h of spines and c of leaves; altogether fairly intermediate (though very different at first sight from the typical hybrid) as 14 : 14, or 50 per cent.

(24) B. empetrifolia is prepotent in h, f, and c of spines and in h, f, and c of leaves; altogether favouring that ancestor as 18 : 12, or 60 per cent.

(25) B. empetrifolia is prepotent in f of stems, in h of spines, and in h and c of leaves, while B. Darwinii predominates in h of flowers; in all, favouring B. empetrifolia as 15 : 13, or 53·5 per cent.

(26) B. empetrifolia is prepotent in h and c of stems, in h, f, and c of spines, in f and c of leaves, and in h of flowers; altogether favouring that ancestor as 20 : 12, or 62·5 per cent.

(27) B. Darwinii is prepotent in c of stems, in h, f, and c of leaves,

and in h, f, and c of flowers, while B. empetrifolia predominates in h of spines; in all, favouring B. Darwinii as 19 : 13, or 59·3 per cent.

(28) B. empetrifolia is prepotent in h, f, and c of spines, in h, f, and c of leaves, and in h and f of flowers, while B. Darwinii predominates in c of flowers; in all, favouring B. empetrifolia as 20 : 13, or 60·6 per cent.

(29) B. Darwinii is prepotent in f and c of stems, in h, f, and c of spines, and in f of leaves; in all, favouring that ancestor as 18 : 12, or 60 per cent.

(30) B. Darwinii is prepotent in c of stems, in f and c of spines, and in f and c of leaves, while B. empetrifolia predominates in h of leaves; in all, favouring B. Darwinii as 17 : 13, or 56·6 per cent.

In addition to the above experiments with Berberis, there are several cases on record which tend to show the stability of hybrids in the Orchideæ, *e.g.*—

Paphiopedilum × Harrisianum, a hybrid between P. barbatum (Pfitz) and P. villosum (Pfitz), has been raised true from seed when fertilised with its own pollen, both by Mr. W. Grey, for Hon. Erastus Corning, Albany, U.S.A., and by Mr. R. M. Grey, for Mr. Graves, of Orange, N.Y.

M. Pauwels, of Boterlaere, France, crossed two distinct varieties of this same hybrid, which duly reproduced the specific characters of P. × Harrisianum faithfully and well.

Again, Mr. W. Grey raised P. × vexillarium, a hybrid between P. barbatum and P. Fairieanum (Pfitz), from self-fertilised seed. Messrs. Veitch, of Chelsea, raised Epidendrum × O'Brienianum, a hybrid between E. radicans (Pav.) and E. evectum (Hook. f.), from self-fertilised seed; but one of the seedlings, while retaining the characteristic shape of the hybrid, almost reverted *in colour* to its grandparent, E. evectum.

This is another illustration of Partial Prepotency, one of the grandparents being prepotent in colour only.

Dean Herbert—the great pioneer of hybridisation in this country—crossed Petunia nyctanigenæflora with P. phœnicea; and the hybrid so raised reproduced itself perfectly true from seed, a large batch of seedlings being raised.

Thus the popular idea that hybrids, when self-fertilised, always revert to one or other of the ancestral species is evidently not founded on fact.

Where this is supposed to have been the case it may possibly have been due to the hybrid being accidentally fertilised with the pollen of one of the ancestral species.

The Vigour of Hybrids.

Most hybrids between distinct species are remarkable for their vigorous habit and large size. Many, too, are more profuse and precocious in their flowering than their parent species. But the vigour of hybrids seems to depend chiefly on their being out-crosses as opposed to being inbred. For I observe in my hybrid Berberis that those of the first generation, raised by crossing the two wild species, are much more vigorous than their parents; but those of the second generation, raised from the first hybrid fertilised with its own pollen, are, as a whole, less vigorous, being fairly normal in this respect. Yet my hybrid Paphiopedi-

lums of the second generation, raised from a first hybrid, out-crossed again with a third species, are more vigorous even than the first hybrids, being quite abnormal in this respect. This seems to show that out-crossing continues to increase the vigour of hybrids abnormally, while inbreeding tends to reduce their vigour to a normal state.

The Limits of Crossing.

In referring to the question of the fertility of hybrids, we saw upon what slight conditions sterility sometimes depends; and yet, if the conditions be favourable, it is remarkable what extreme forms of plants can be united by hybridisation. For instance, in the Orchideæ, during the past decade not only have many distinct species been successfully united, but, as we have already seen, numbers of distinct genera hybridise together with ease.

The four genera Lælia, Cattleya, Epidendrum, and Sophronitis are now all united by hybridisation, as are Zygopetalum, Colax, and Batemannia. These hybrids have all flowered in gardens, and show the characters of their parent genera. In addition to these are numerous records of generic crosses, yet unflowered, though plants or seeds have been produced.*

The most extreme of the flowered generic hybrids in Orchideæ are apparently those between Phaius and Calanthe, genera belonging to distinct sub-tribes, so that the generic limit even has now been surpassed, and that of the sub-tribe reached. Is it possible to go farther than this? I think so, the relationship between many of the generic hybrids, yet unflowered, being much more remote.

I have made a number of experiments in crossing distinct genera in the Orchideæ, and, though many failures have resulted, yet some have proved rather interesting. For instance, Sophronitis × Cattleya, Sophronitis × Lælia, Paphiopedilum × Phragmipedilum, Cypripedilum × Phragmipedilum, Paphiopedilum × Cypripedilum, Oncidium × Odontoglossum, all produced healthy capsules, containing some good seeds, many of which are now germinating; while Lycaste × Lælia, Angræcum × Lælia, Angræcum × Vanda, Paphiopedilum × Odontoglossum, and Paphiopedilum × Dendrobium all produced fully developed capsules, which opened naturally in due time, but which contained no good seeds. Again, Ada × Lælia, Cattleya × Angræcum, Dendrobium × Odontoglossum, Epidendrum × Dendrobium, Epidendrum × Odontoglossum, Cattleya × Dendrobium, all produced partly formed capsules, which ultimately faded; while Lælia × Lycaste, Dendrobium × Cattleya, Paphiopedilum × Cattleya, Epidendrum × Dendrobium, and Epidendrum × Paphiopedilum all failed to set capsules.

Incompatibility of structure, apart altogether from systematic affinity, may have something to do with the limitation of crossing, for I observe in the above experiments that in all the instances where Sophronitis was crossed with Cattleya, when Sophronitis was the seed parent, good seeds were obtained, which duly germinated; while the reverse crosses, made at the same time and under the same conditions, in every case failed to set a capsule.

* See *Jour. Roy. Hort. Soc.* xxi. [1898], p. 468.

Now Sophronitis has a very short column, while Cattleya has a decidedly long one, and one can quite understand that while it would be an easy matter for the pollen tubes of Cattleya to reach the ovules of Sophronitis ; yet, on the other hand, it would be much more difficult for the pollen tubes of Sophronitis to reach the ovules of Cattleya, owing to the length of the column duct in the latter.

Incompatibility of colour seems to have something to do with the limitations of crossing, for Darwin gives us a large number of facts where colour varieties of the same species were more or less infertile when crossed.

The limits of crossing do not seem to be determined *so* much by systematic affinity or natural relationship ; for, as we have seen, some very distinct genera cross with ease, while some closely allied species refuse all attempts to unite them. I have found Oncidium flexuosum always infertile when pollinated with its own pollen, yet quite fertile when fertilised with pollen of O. Forbesii, a distinct species. Nor do the limits of crossing depend upon constitutional differences, for annuals can be crossed with perennials, deciduous trees with evergreens, plants from the tropics with plants which reach to the Arctic Circle. To sum up the whole question, we can only ascertain the true limits of crossing by actual experiments.

It is encouraging to find that the more experiments made, the more barriers there are removed, the wider become the limits of crossing. The main thing is not to be discouraged by failures, but to try again and again, and above all to keep precise records, both of the successes and the *failures*, which records may prove to be of inestimable value to science.

(*End of the first day's Conference.*)

CONFERENCE.

WEDNESDAY, JULY 12, 1899, AT WESTMINSTER.

Introductory Remarks by the Rev. Professor GEO. HENSLOW M.A., V.M.H.

I have been asked by our Secretary to take the place of Sir Michael Foster, who, I am sorry to say, is seriously ill, confined to his bed, and cannot possibly be with us to-day, I regret this very much, and so, I am sure, shall we all, as from Sir Michael we should have had a most valuable introductory address. At the very last moment I have been asked to open the proceedings. You will not therefore expect me to give you an introductory address, as I said almost all I had to say yesterday. But there is just one remark I should like to make. The great value of these meetings is that we connect together the scientific aspect with the practical. Not only does this apply to hybridisation, but to all departments of botany. The botanist studying physiological laws of plants would only be too thankful to get the facts which the hybridist is familiar with; while by the bringing forward of the scientific aspect, the practical man's work is much expedited. So we work, and should always work, hand in hand.

WORK OF THE UNITED STATES DEPARTMENT OF AGRICULTURE ON PLANT HYBRIDISATION.*

By HERBERT J. WEBBER, in charge of the Plant-breeding Laboratory.

WHILE some work on plant-breeding has been in progress in the United States Department of Agriculture for a number of years, until recently it has been almost wholly in the line of simple selection without the direct application of hybridisation and cross-breeding. The work on hybridisation proper as a means of securing variations and improvements was started only a few years ago, and as yet all the work is in an uncompleted state. Some points of interest have been secured, however, and I shall briefly describe some of these in this paper. The work thus far undertaken has been mainly on Oranges, Grapes, Pineapples, Pears, Apples, Wheat, Corn, and Cotton. It will not be possible to discuss all of the experiments in progress, and features will be selected here and there which it is thought will be of interest to the members of the Conference. The work on Oranges and Pineapples which will be described has been conducted by the writer in conjunction with Mr. Walter T. Swingle, and equal credit should be given him for any factors of importance brought out. Owing to the unfinished condition of the work this paper will largely treat of the improvements which it is desired to secure, with an indication of the progress made.

ORANGE HYBRIDISATION.

The work on the hybridisation of the Orange and other citrous fruits was begun in 1893, but was greatly interrupted by the severe freezes in the winter of 1894 and 1895, and again last winter, February 1899, when a number of the hybrids which would have fruited this year were frozen down. We have secured about 2,000 citrous hybrids which are being grown and tested, but none of these have yet fruited, and the comparisons given below are accordingly based entirely on foliage characters, habits, &c.

A Hardy Orange.—The most important development that we are striving to produce in citrous fruits is a hardy Orange which will withstand the severe frosts that occasionally cause such serious damage in the Orange regions of the United States. This we hope to secure by hybridising the Japanese Trifoliate Orange (*Citrus trifoliata*) with the various varieties of the Common Sweet Orange (*C. aurantium sinensis*). The Trifoliate Orange is a deciduous trifoliolate tree which is perfectly hardy as far north as New York, and is coming to be used extensively as a hedge plant. The fruit is small and bitter, and is generally considered worthless:

* In this paper the term "hybrid" is used, comformable to the *Century Dictionary*, as a generic term to include all organisms arising from a cross of two forms noticeably different, whether the difference be great or slight. Adjectives are sometimes used to indicate the grade of the forms resulting from a cross, such as racial, varietal, or bigeneric hybrids. Where a hybrid of two races or species is crossed with a third race or species a triracial or trispecific hybrid would result. (See discussion on this point in *Year-book*, United States Department of Agriculture, 1897, p. 384.)

it is, however, sometimes used for preserves. It is very late in starting in the spring, the flowers appearing before the foliage, and not even showing till the Common Orange is nearly out of bloom. It is thus regularly about a month later in starting in the spring than the common Orange and other citrous fruits, and is never caught by late frosts. Again in the fall it ripens it fruits early, and becomes dormant a considerable period before the Common Orange. The Common Orange, on the other hand, is an evergreen unifoliolate tree growing more or less during the entire winter unless checked by severe cold. Judging from the results which have been obtained with other plants it seems perfectly possible by crossing and recrossing the Orange with the hardy *trifoliata* to ultimately secure a hybrid combining the fruit characters of the former with the hardiness of the latter.

Many instances are recorded where hybrids have been obtained combining certain characters of the parents, but only a few are known to the writer where increased hardiness has been secured. According to Verlot,* the forms of *Rhododendron arboreum* are rendered hardier by crossing with *R. catawbiense.* Macfarlane has called attention to the hardiness of a hybrid between the hardy *Montbretia Pottsii* and *Tritonia aurea*, which latter is easily injured by cold. He says, referring to the winter of 1891–92: "The corms of the first (*Montbretia*) appear scarcely to have been injured. Those of the hybrid have been largely killed off, at least to the extent of sixty per cent., while *Tritonia*, never hardy in exposed ground, has survived only where it is planted against, and can creep along, the outer side of a hothouse wall."† A second case is also described by Macfarlane where a hybrid between a hardy and a tender species is intermediate in hardness between the two. He says: "*Philesia buxifolia* is a hardy plant, and resists well our winter colds. *Lapageria rosea* requires the temperature of a cold hothouse to flourish, while the bybrid succeeds if kept protected from frosts and the more cutting winds. In the southern counties of Britain it lives and flowers out of doors."† A similar case of increased hardiness secured by hybridisation is cited by Manda: "By crossing *Rosa Wichuraiana* with greenhouse Teas the result is astonishing, as the plants are not only hardy but retain their foliage during the winter. Thus a new race of evergreen Roses has been added to our collection, and promises to be the beginning of a new and useful class."‡

The change desired in the Orange is not so great as one is at first inclined to think. If by infusing a slight portion of the *trifoliata* blood into the Orange we can somehow modify its habits of growth and cause it to remain more dormant through the winter, and later into the spring, we have accomplished our aim, and this, we think, is perfectly possible. The production of Grape hybrids having the resistance to *Phyloxera* of certain of the American species such as *Vitis riparia* and *V. rupestris*,

* Verlot, Jean Baptiste, "Sur la Production et la Fixation des Variétés dans les Plantes d'Ornement," cited in Bailey's *Plant Breeding*, p. 145.

† Macfarlane, Dr. J. M., "A Comparison of the Minute Structure of Plant Hybrids with that of their Parents, and its Bearing on Biological Problems," *Trans. Royal Soc. Edinburgh*, vol. xxxvii. Pt. I. No. 14, p. 258.

‡ Manda, W. A., "Hybrid Wichuraiana Roses," *Gardening*, vol. vi. No. 145, Sept. 15, 1898, p. 9.

and the fine fruits of the European varieties, which it is claimed have been obtained by certain French hybridisers, is an accomplishment of

1 2 3

Fig. 42.—Citrous Hybrids, showing comparative vigour.

this nature. On the other hand it seems within the limit of possibility to secure an early ripening strain, possibly deciduous, which will be very much hardier than any of the desirable varieties now known.

The Common Orange and *C. trifoliata* are very distinct in character, and are somewhat difficult to hybridise. In my personal work I find that, even using the utmost care, only about one twentieth of the flowers pollinated seem to be affected by the cross, and only about one per cent. of the flowers cross-pollinated finally mature fruit. There is a further loss in the small percentage of germination, not more than half of the seeds germinating. We have secured quite a number of hybrids, however, where both the Orange and *trifoliata* were used as the seed-bearing parent. Some of these plainly show characteristics of both parents, and are doubtless true hybrids. Out of forty hybrids of the *trifoliata* crossed with pollen of the Sweet Orange, twenty-nine resemble the Trifoliate Orange in habit and foliage characters so far as can be observed, while eleven are clearly intermediate in these characters. These eleven intermediate plants are very similar to each other, and apparently derive certain characters from each parent. The leaves are trifoliolate but are much larger than those of normal *Citrus trifoliata.* The central leaflet has a tendency to enlarge, while the lateral leaflets remain about the normal size or in some cases are reduced in size. (Compare fig. 42, which gives a hybrid (772) between its two parent species, all three being seedlings of the same age.)

The majority of the species of Citrus are polyembryonic, several embryos developing in one seed, and frequently giving several seedlings when germinated. This introduces an interesting complication into citrous hybridising. Strasburger * has shown that the egg cell proper is apparently fecundated in the normal way, and develops into a single embryo, and that the other embryos are developments from certain cells of the nucellus (the mother tissue), near the apex of the embryo sac, which become enlarged and divide, and finally push out into the embryo sac, forming what are termed adventive embryos. When fully developed in the mature seed, these adventive embryos cannot be distinguished from the embryo developed in the normal way from the fecundated egg cell. In many cases a seed from a hybrid fruit has yielded more than one seedling, and in several instances seedlings from the same seed are of totally different character, showing that one has been affected by the hybridisation while the others are like the mother parent. In such cases it seems evident that the intermediate seedling which shows the effect of the male parent is from the embryo, resulting from the development of the fecundated egg cell, while the seedlings resembling the mother parent only, are developed from the adventive embryos, which, as explained above, arise directly from cells of the mother parent without any intervention of the male element.

In the pot shown in fig. 43, No. 2, three seedlings are developing from a single seed of a Tangerine Orange which was crossed by Mr. Swingle with pollen of *trifoliata.* One of the seedlings has trifoliolate leaves, while the other two have unifoliolate leaves like the mother parent. There can be no possible doubt that these three seedlings come from the same seed, as this difference was plainly visible when the seedlings were about an inch high, and fearing that there might be an error I carefully

* Strasburger, Dr. Eduard, "Ueber Polyembryonie," *Jenaische Zeitschr. für Naturwissensch.* XII.

dug up the seed and found them still connected with the cotyledons and all encased in the same seed coat. The same precaution was taken in another similar case, and the fact of the occurrence of such cases, is beyond a question of doubt, whatever be the interpretation. There can be but little doubt that here the trifoliolate seedling comes from the embryo developing from the egg cell proper, and shows the effect of the hybridisation, while the other two seedlings resembling the Tangerine mother plant are from adventive embryos. It should also be noticed that the leaves of the trifoliolate seedling are much larger than those of typical *trifoliata*, as is plainly shown by a comparison with a

1 2 3 4

FIG. 43.—TRUE AND FALSE CITROUS HYBRIDS.

trifoliata seedling shown in fig. 43, No. 1. A similar case, of different parentage, is shown in fig. 43, No. 3. The seed of No. 3 was the result of a cross made by Mr. Swingle of *trifoliata* with pollen of the Sweet Orange. Here the seedling with large leaves is doubtless from the embryo affected by the hybridisation, while that with fewer and smaller leaves resembling true *trifoliata* (in this case the mother parent) is doubtless from an adventive embryo. The reciprocal hybrids of the above, when the Sweet Orange is used as the mother parent and the *trifoliata* as the father parent, several of which have been secured, frequently exhibit the same phenomenon (see fig. 45, No. 1). Similar cases have occurred among our hybrids of Orange and Pomelo, and Orange and Tangerine.

All of the forty hybrids of the Trifoliate Orange crossed with Sweet Orange mentioned above were from a single fruit. In the case of the eleven seedlings which plainly show intermediate characters there can be but little doubt but that they are all from embryos developed from egg cells proper, and thus true hybrids. In the case of the twenty-nine hybrids which show no effect of the male parent it is very doubtful whether they may not be developments from adventive embryos. It seems prob-

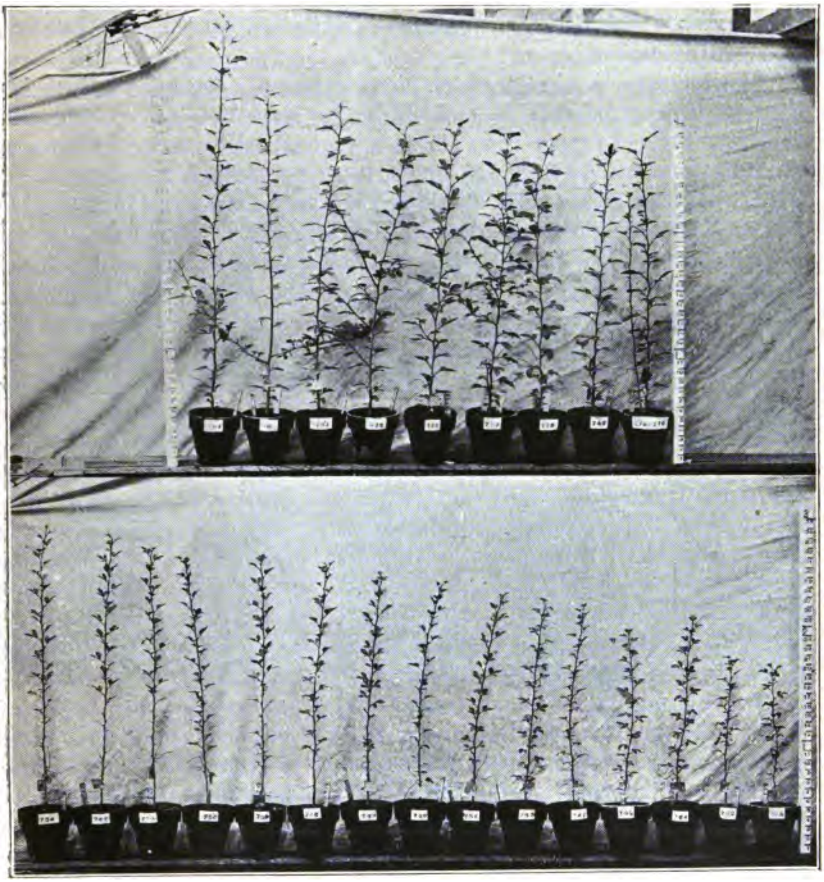


FIG. 44.—TRUE AND FALSE HYBRIDS FROM THE SAME FRUIT OF C. TRIFOLIATA × C. AURANTIUM SINENSIS.

able that the fecundation of a few seeds of a fruit may stimulate the development of other seeds not fecundated, where the only embryos formed are developed adventively, and are not affected by the hybridisation except indirectly so far as the stimulation to development is concerned. In the pots shown in fig. 43, Nos. 1 and 4, two seedlings have developed from a single seed in each case, and in neither case do either show any effect of having been crossed with the Sweet Orange. Those seedlings from hybridised fruits, which show no effect of the male parent, and

seem to come from adventive embryos, I shall speak of here as "false" hybrids for the sake of clearness.

Another feature of importance shown by the true hybrids is their evergreen habit. In March, when the seedlings were transplanted to the south, all of the false hybrids (fig. 44, lower row) were dropping their leaves as true Trifoliate Oranges normally do in the winter. All of the true hybrids, however (fig. 44, upper row), as yet showed no signs of dropping their foliage, and were clearly distinct in this feature. This is also shown well in fig. 43, No. 3, where in two seedlings from the same seed the hybrid is evergreen, while the false hybrid has lost nearly all its leaves.

The increase in vigour, which is so commonly displayed by hybrids between distinct parents, is also shown by these hybrids to a marked degree. Fig. 44 (upper row) shows a representative series of nine of the true intermediate hybrids, which is to be compared with a representative series of the false hybrids shown in the lower row of the same figure. The true hybrids are all much larger and more branched than the false hybrids, which are, as explained above, supposed to be developed from adventive embryos, and thus to be true representatives of the mother parent. The growth is also much more rapid and vigorous than in the normal male parent, which may be seen by comparing fig. 42, where all seedlings are of the same age. No. 845, a cross of two typical Oranges and one of the largest of 500 seedling Oranges of similar kind, is yet far smaller than the medium-sized true hybrid No. 772. No. 780, one of the largest of the twenty-nine false hybrids, affords a relative comparison of size of the true hybrids with the type of the mother parent. The true hybrid No. 772 used here for comparison is not the largest of the hybrids secured, but is of medium size. (See fourth in series, fig. 44, upper row.) In case two or more seedlings develop from the same seed, the one developing from the egg cell and affected by the crossing with the male element, is almost invariably the strongest and largest, which is, of course, what would be expected. (Fig. 43, No. 2, and fig. 45, No. 1.)

The hybrids described above are of *trifoliata* crossed with pollen of Sweet Orange, but the reciprocal hybrids obtained show the same characters and about an equal proportion of intermediate plants or true hybrids. Of fourteen hybrids of Sweet Orange crossed with pollen of *trifoliata* nine seedlings are, so far as can be observed, exactly like the typical mother parent, and are possibly false hybrids, while five are intermediate in nature, resembling the male parent in having trifoliolate leaves, which are much larger than typical *trifoliata*. (Fig. 45, Nos. 1 and 2, and fig. 46, No. 716.) It is interesting to note that here, where the Sweet Orange is used as the mother parent, in the five cases of seedlings showing intermediate nature all are trifoliolate, though coming from seeds of an unifoliolate species, and show almost exactly the same intermediate characters as are shown by the reciprocal hybrids, where the *trifoliata* is used as the mother parent and the Sweet Orange as the father parent.

In crosses of the Tangerine (*Citrus nobilis*) with pollen of the Trifoliate Orange the same feature is exhibited. Of twelve such hybrids eleven resembled the Tangerine in foliage characters, &c., while one has

trifoliolate leaves, somewhat larger than the normal leaves of *trifoliata*, clearly showing the influence of the pollen parent. It is interesting to note here also that the trifoliolate seedling is the largest of the series.

Loose Skin of Mandarin.—A second improvement of importance which it is desired to produce is a fruit having the quality and flavour of the finest varieties of the Common Orange with the loose, easily removable skin of the Mandarin type of Orange (*C. nobilis*). With this object in view a number of hybrids have been made, principally between the Tangerine, the best sort of Mandarin Orange in cultivation, and various varieties of the Common Orange. *Citrus nobilis* is much more closely related to the Common Orange than the *C. trifoliata*, and the hybrids seem to be much more variable in the first generation, some very closely resembling the parents, while others are apparently intermediate as far

1 2 3 4 5

FIG. 45.—HYBRIDS OF SANDFORD'S MEDITERRANEAN (C. AURANTIUM SINENSIS) × C. TRIFOLIATA.

as can be judged from foliage characters. Here, however, the characters of the parents are more nearly alike, and it is only in the extreme variations that the foliage resemblances can be clearly distinguished. In almost every case, however, the great majority of the seedlings resemble the mother parent in the main, while comparatively few show plainly the effect of the male parent. Among 286 hybrids of the Tangerine crossed with pollen of Common Orange 247 seemed mainly to resemble the Tangerine in foliage characters, while thirty-nine show more resemblance to the Common Orange.

The reciprocal hybrids, where the Common Orange was crossed with pollen of Tangerine, show the same features, the majority of the seedlings resembling the mother parent, and only a small percentage of them showing the effect of the male parent. In fig. 47, showing seven seedlings of the Ruby Orange ♀ × Tangerine ♂, the large seedlings in Nos. 1

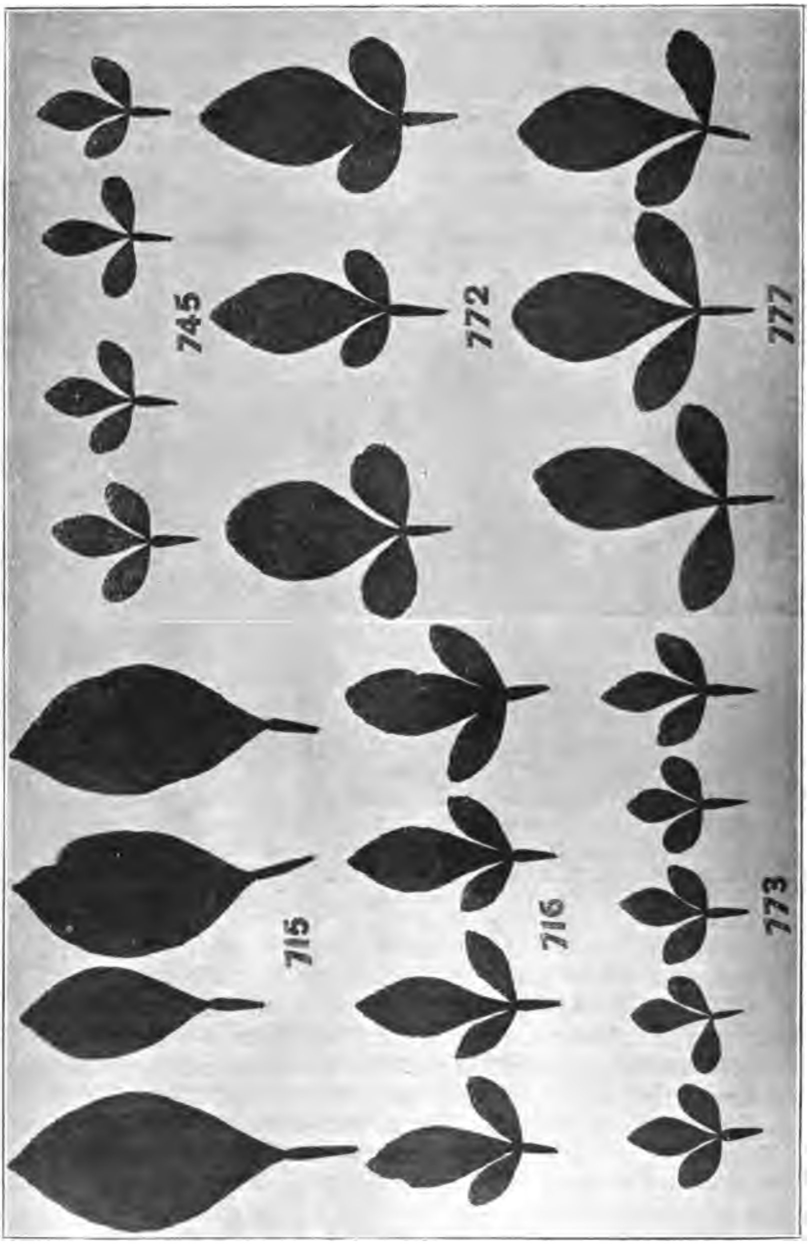


Fig. 46.—Leaves of True and False Citrous Hybrids.

and 3 resemble the mother parent mainly, while the large seedlings in Nos. 2 and 4 show the effect of the father.

It is equally important to secure fruits of the Pomelo type, which have the easily removable skin and easily separable segments of the Mandarin type of Orange, and to secure improvements in this direction many hybrids of the Tangerine and Pomelo have been made. The resulting seedlings, as in the case of the Tangerine Orange hybrids, mainly resemble the mother parent; but the Pomelo foliage being more markedly different from the Tangerine than that of the Orange, the differences are much plainer. Of 116 hybrids of the Pomelo crossed with pollen of Tangerine 111 had plainly the broad-winged petioles and robust foliage of the female parent, while only five showed the foliage characters of the Tangerine or male parent. No reciprocal hybrids were made in this case.

1 2 3 4

FIG. 47.—HYBRIDS OF RUBY ORANGE (C. AURANTIUM SINENSIS) × TANGERINE (C. NOBILIS).

Change of Quality.—Among the varieties of citrous fruits now cultivated are several fairly desirable fruits, quite distinct in their characters, which from their appearance seem to be hybrids of the Orange (*C. aurantium sinensis*) and Pomelo (*C. decumana*). The variety known as the Aurantium-Pomelo is so called because of its supposed hybrid nature. A fairly well-known Jamaican Pear-shaped Pomelo of small size, with orange-yellow skin and Pomelo-like pulp, seems also to be a hybrid between these two species. We have made quite a number of crosses of these species, hoping to secure fruits markedly different from those now in cultivation, and which will prove valuable commercial varieties. Of 126 hybrids of the Pomelo with pollen of the Orange 106 resembled the mother parent and twenty the male parent.

Resistance to Disease.—The Sour Orange (*C. aurantium amara*) has been found by extended observations to be largely immune to the so-called "blight," which is probably the worst Orange disease known in Florida. Hoping to secure desirable sorts of sweet edible Oranges immune to this disease, the Orange was crossed with pollen of the "Bitter Sweet," which is the best variety of the Sour Orange. The twenty-seven hybrids of this parentage are the most variable of any set or combination of citrous hybrids which we have obtained. Some have leaves almost exactly like the Bitter Sweet, others almost exactly like the Orange, others present a totally distinct shape of leaf from either parent. Of these twenty-one resemble in main the mother, and six in main the male parent.

Other hybrids were made for various minor improvements, but it is not desirable to discuss them further here.

Summary of Resemblances of Citrous Hybrids.—In the hybrids of the widely distinct species the seedlings divide themselves plainly into two classes: (1) Those resembling the mother parent entirely, so far as could be determined; and (2) those intermediate in character.

Parentage	Total number of seedlings	Number resembling mother	Number intermediate
Trifoliata ♀ × Sweet Orange ♂ . .	40	29	11
Sweet Orange ♀ × *Trifoliata* ♂ . .	14	9	5
Tangerine ♀ × *Trifoliata* ♂ . . .	12	11	1

In the hybrids of closely related species, such as Orange × Pomelo and Orange × Tangerine, the intermediate nature of the hybrids, if they are intermediate, cannot be easily distinguished. In foliage and other characters, so far as exhibited previous to fruiting, they seem to resemble very closely either the mother or father parent. The following table will show the proportion of their resemblance:—

Parentage	Total number of seedlings	Number resembling mother	Number resembling father
Tangerine ♀ × Sweet Orange ♂ . .	286	247	39
Sweet Orange ♀ × Tangerine ♂ . .	75	69	6
Pomelo ♀ × Tangerine ♂	116	111	5
Pomelo ♀ × Sweet Orange ♂ . . .	126	106	20
Sweet Orange ♀ × Pomelo ♂ . . .	103	95	8
Sweet Orange ♀ × Bitter Sweet ♂ . .	27	21	6
West Indian Lime ♀ × Sicily Lemon ♂ .	11	9	2
Sicily Lemon ♀ × West Indian Lime ♂ .	9	9	0
West Indian Lime ♀ × Pomelo ♂ . .	4	4	0

Pineapple Hybridisation.

The principal problems here presented are to secure—1, better shipping sorts; 2, smooth-leaved sorts; 3, sorts resistant to disease; and 4, sorts having larger fruits of better quality. These objects have been kept clearly in view in all of our work. Pineapples, as is well known, are almost totally seedless. Among the fruits which reach the American markets from the Bahamas, West Indies, and Florida it is

very seldom that a perfect seed is found. So rare is this that most people, and even some botanists, consider it to be a totally seedless fruit. It is interesting to note here that the stigmas are apparently always abundantly dusted with pollen from the same flower, and it is plain that they are either self-sterile or that the pollen is imperfect. A microscopic examination, however, of the pollen of the Red Spanish variety showed the pollen to be perfectly normal so far as could be judged.

In the spring of 1896 I crossed a number of flowers of the Mauritius Pineapple with pollen of the Red Spanish variety simply as a preliminary trial to see whether seeds could be induced to set by crossing different sorts or varieties. In this experiment a number of apparently perfect seeds set, some fifteen of which germinated and grew. In the spring of 1897 Mr. W. T. Swingle made numerous other crosses, and the following year, the spring of 1898, I continued the work myself. As a result of this work we now have some 500 seedlings showing many interesting foliage variations. The 24-month-old seedlings have reached a height of 6 or 8 inches, being as large as the slips commonly used in planting fields, and it would seem from their size that many will fruit in the summer of 1901. If size and rapidity of growth can be taken as an indication they surely will not require eight years from seed to fruit, as I have seen somewhere stated.

In the course of the work it has been observed that certain sorts are apparently sterile to each other's pollen, no seeds setting even when carefully crossed. As an illustration, fifty flowers of Pernambuco crossed with pollen of Porto Rico gave no seeds; and thirty-nine flowers of Porto Rico crossed with pollen of Pernambuco, the reciprocal cross to the above, also gave only one single seed, and that imperfect.

In my own experience the most fertile varieties are the Abbaka and Smooth Cayenne, two of the finest varieties known. Ninety-seven flowers of Abbaka crossed with pollen of Smooth Cayenne gave seventy-seven good seeds, and, in the case of the reciprocal cross, thirty-six flowers of the Smooth Cayenne crossed with pollen of Abbaka gave forty-six perfect seeds. Other sorts used in crossing, such as Golden Queen, Ripley, Red Spanish, Mauritius, &c., gave varying degrees of fertility between these two extremes.

Cotton Hybridisation.

The production of Cotton is one of the most extensive industries of the Southern United States, and furnishes many problems to tax the skill of the plant breeder. The so-called Sea Island Cotton, *Gossypium barbadense*, grown in a limited area mainly on islands near the coast of Georgia and South Carolina, furnishes the longest and finest staple produced anywhere in the world. The Upland Cotton, *Gossypium herbaceum*, which is the kind grown all over the interior, produces a comparatively short and coarse staple. If by hybridising the fine Sea Island with the different varieties of the Upland a race can be secured suitable to growth in the interior regions, and yielding a finer and longer staple, the industry will be greatly benefited. This would seem to be a comparatively simple problem, but it is complicated by the necessity of securing, not only a

M H F

Fig. 48. — Cotton Hybrid and its Parents, showing comparative vigour.

longer and finer staple, but, to be of any value, it must be borne on a smooth black seed, like the Sea Island type, so that the fibre can be ginned

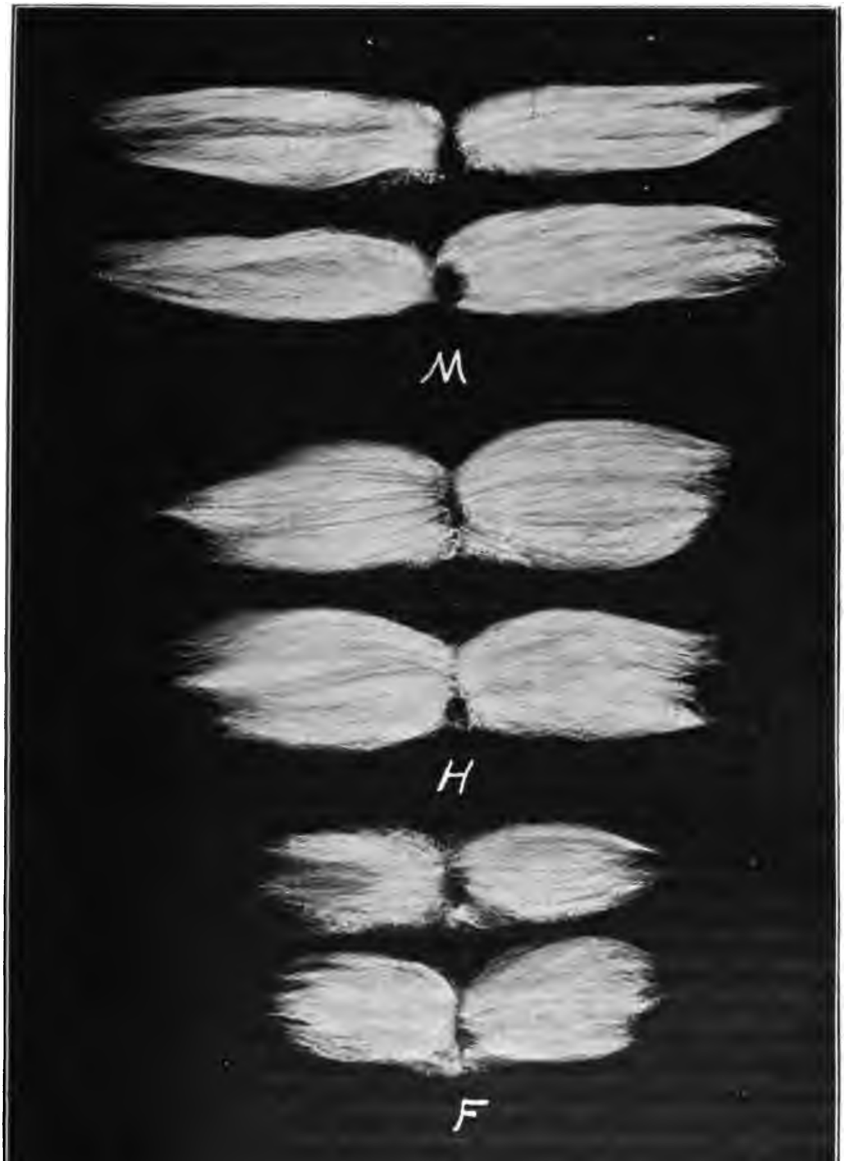


Fig. 49.—Seeds of Hybrid Cotton and of its Parents, with the Fibre pulled out to show the relative Length and Amount in each case.

M, Fibre of 'Sea Island'; F, of 'Upland'; H, of 'Klondyke,' the Hybrid between them.

on a roller gin. In the ordinary Upland, where the fibre varies from $\frac{3}{4}$ to $1\frac{1}{4}$ inches long, the seed is covered with a dense coating of short hairs—is a "tufted" seed as the growers say—and this prevents the use of the roller gin, a saw gin being necessitated. The saw gin tears the fibre so seriously that there is no object in increasing its length unless it is borne on a smooth seed, so that the roller gin can be used. Mr. W. A. Clark, a careful planter, of Columbia, South Carolina, who is co-operating with the Department of Agriculture in this work, early realised the difficulties in the problem and took up the first necessary step—the production of a smooth-seeded strain of the Upland Cotton. This he secured, after five or six generations of careful selections, in a strain which he called the 'Klondike.'

In the ordinary sorts of Upland Cotton smooth black seeds, similar to those of the Sea Island Cotton, are occasionally found mixed with the ordinary tufted or green seeds. Originally certain Upland sorts, such as Peterkin, had smooth seeds, and the production of such seeds in sorts commonly having tufted seeds may be due to hybridisation of the ancestors of the plant with the Sea Island or some smooth-seeded sorts of the Upland.

Mr. Clark selected at random and planted a quantity of smooth black seeds from the ordinary Upland Cotton, and the great majority of the resulting plants produced the ordinary tufted seed ; but a few had mainly smooth black seed like those from which the plants were grown. Seeds were selected from the few plants which produced mainly smooth black seed, and were planted the second year. This season a much larger proportion of the plants produced smooth black seed, but still many produced the ordinary tufted seed. Seeds were again selected from the plants producing smooth seed and planted the third year, and so on through five generations, when the character was fully fixed and all the plants came true, producing only the smooth black seed.

The 'Klondike' was then hybridised with the Sea Island, and while it is too early to pronounce as to the practical value of the hybrids secured, some are exceedingly promising, having fibre intermediate in length and fineness between the two parents, and more abundant than in either (fig. 48, H). It is also interesting to note that here, again, the increased vigour so commonly resulting from hybridising different species and races is very markedly exhibited in many cases.

A second important problem in Cotton breeding which is receiving attention is the production of a tawny Cotton of a grade similar to the Egyptian, which is extensively imported into the United States, and manufactured largely into fine underwear, &c. The Egyptian varieties so far as yet tested in the United States have failed to give satisfactory results, and it seems that races especially adapted to conditions obtaining there must be secured. Experiments are under way in crossing the varieties of the Sea Island and Upland grown in the United States with the Egyptian races, and with the dark brown Pieura or Peruvian Cotton with a hope of securing brown or tawny races suited for culture in the United States which will take the place of the tawny Egyptian Cotton now imported.

Corn or Maize Hybridisation.

Only very few of the numerous important problems here presented to the plant breeder have as yet been taken up. In the hope of securing better-yielding races the exceedingly large-kernelled Cuzco, or Peruvian Corn recently imported into the United States by the Department of Agriculture, was used in hybridising with certain of our best races. The Hickory King, a very large-kernelled white dent, and Leaming, a well-known yellow dent, were used as the seed-bearing parents. The Cuzco, from which the pollen for the hybrids was obtained, was grown from kernels of a graphite colour, this colour being distinct from that of any race of Corn in the United States with which I am familiar.

The current or immediate effect of pollen (xenia), so commonly reported as occurring in Corn, was shown in these hybrids; and although no check experiments were made (the work not being carried on to demonstrate this feature), there can nevertheless be no doubt that the coloration was due to the effect of the pollen. The seed of the Hickory King and the Leaming used was grown by careful seedsmen, and strict attention was given to keeping it pure and true to type. None of the ears except those which had been crossed showed any indication of impurity. Some of the kernels of the Hickory King ears crossed with the pollen of the Cuzco showed irregular spots of the characteristic graphite colour of the Cuzco, while others were entirely of a slate colour, these being somewhat lighter in colour than those of the typical Cuzco. So far as could be observed, the Cuzco used was not a fixed type, some of the kernels being mottled with red, olive purple, or brown. In a few instances the immediate effect of the pollen was apparent in Leaming crossed with Cuzco,* the kernels showing a peculiar admixture of the colours of the parents, that is of dark olive purple and the orange yellow. In the case of the hybrids of Hickory King with Cuzco grown from kernels showing the immediate effect of the pollen, which were marked when planted, their increased vigour, purple stalks, and whorls of anchor roots (inherited from the Cuzco, the male parent) showed that they were without question hybrids of the two races named. In the same characteristic way the influence of the male parent was evident in many of the hybrids from kernels in which no immediate effect of the pollen was shown. All hybrids showing intermediate characters were very late in flowering, which is another characteristic of the Cuzco, it being a tropical plant, and therefore requiring a long season to develop. These hybrids as a rule matured slightly earlier than the Cuzco plants in the same field.

Other hybrids have been made with a view of securing sorts that will yield better in northern regions, where flint Corn, which ripens early but is a poor yielder, is now grown. Some of these hybrids are very promising; for instance, one of Gilman Flint (a good race of the flint Corn) when crossed with Leaming pollen produced ears almost twice as large as those produced by the Gilman Flint grown under similar conditions, there being sixteen rows of kernels on the ear instead of twelve,

* The crosses of Leaming with Cuzco were made by Mr. E. C. Rittue, gardener of the Division of Vegetable Physiology and Pathology, at my request.

as in the Gilman Flint, and the kernels being much larger. This hybrid ripened nearly as early as the Gilman Flint, being secure from injury by frost three months after it was planted.

It is the intention of the Department to test such hybrids in the regions to which they seem best adapted, and to fix races of such as are found valuable.

Conclusion.

What has been said above will serve to show the character of the work on plant breeding, which it is the intention of the Department of Agriculture to foster, and also to call attention to some of the important problems which are now receiving attention. The vast diversity of soil and climatic conditions afforded by our great extent of territory renders it necessary for us to have very many different sorts of cultivated plants. An important and almost illimitable field is thus opened for the plant breeder, and we hope that the work on this subject in the Department of Agriculture may soon assume such scope and magnitude as its importance demands.

Explanation of Figures.

Fig. 42.—Citrus hybrids, showing comparative vigour: 772, hybrid of *Citrus trifoliata* ♀ × *C. aurantium sinensis* ♂, a medium-sized seedling selected from nine hybrids of same parentage; 780, type of female parent (*C. trifoliata*), one of the largest of thirty seedlings; 845, type of male parent (*C. aurantium sinensis*), one of the largest of nearly five hundred seedlings. These three seedlings are all of the same age.

Fig. 43.—True and false citrous hybrids: No. 1, false hybrids of *C. trifoliata* ♀ × *C. aurantium sinensis* ♂ from same seed, both hybrids resembling the female parent only; No. 2, three hybrids of Tangerine Orange (*C. nobilis*) ♀ × *C. trifoliata* ♂ from one seed, the largest, with trifoliolate leaves, being a true hybrid, while the two small ones, resembling the female parent only, are false hybrids; No. 3, two hybrids of *C. trifoliata* ♀ × *C. aurantium sinensis* ♂, both from same seed, the one on the left, with large leaves, being a true hybrid, and the one on the right, with small leaves, being a false hybrid; No. 4, two false hybrids of *C. trifoliata* ♀ × *C. aurantium sinensis* ♂, both from same seed, resembling female parent only.

Fig. 44.—True and false hybrids from same fruit of *C. trifoliata* ♀ × *C. aurantium sinensis* ♂, showing comparative size. Upper row true hybrids, lower row false hybrids.

Fig. 45.—Hybrids of Sandford's Mediterranean (*C. aurantium sinensis*) ♀ × *C. trifoliata* ♂. Trifoliolate seedlings in pots Nos. 1 and 2 are true hybrids, being intermediate between the two parents; the others are apparently false hybrids, resembling the female parent only.

Fig. 46.—Leaves of true and false citrous hybrids: 715 and 716, false and true hybrids respectively of Sweet Orange (*C. aurantium*) ♀ × *C. trifoliata* ♂; 773 and 745, false hybrids of *C. trifoliata* ♀ × *C. aurantium sinensis* ♂; 772 and 777, true hybrids of *C. trifoliata* ♀ × *C. aurantium sinensis*.

Fig. 47.—Hybrids of Ruby Orange (*Citrus aurantium sinensis*) ♀ × Tangerine (*C. nobilis*) ♂: No. 1, seedling resembling female parent; No. 2,

largest seedling, intermediate between parents, two small seedlings, apparently false hybrids; No. 3, seedlings resembling female parent; No. 4, seedling resembling male parent.

Fig. 48.—Cotton hybrid and parents, showing comparative vigour: F, Upland Cotton, female parent; M, Sea Island Cotton, male parent; H, Hybrid. (These plants were photographed under the direction of Mr. W. A. Clark.)

Fig. 49.—Seeds of hybrid Cotton and of parents, with fiber pulled out to show length and amount: F, ordinary Upland, female parent; M, Sea Island, male parent; H, Hybrid.

Discussion.

The Chairman: We are all greatly indebted to Mr. Webber for his admirable lecture, and also to the Government of the United States for having sent him to tell us what they are doing. His lecture has been a practical illustration of the remarks I made at the beginning, of science and practice working harmoniously together for the mutual benefit of each.

Mr. C. C. Hurst: I should like to ask Mr. Webber, in the case of those hybrids which he said resemble one parent or the other, to be kind enough to tell us whether they resemble one parent in all characteristics, or simply in one or two.

Mr. Webber: In all, so far as can be observed. In growth, character of the stem, and so on, they resemble one or the other parent.

Mr. Bateson: I should like to know whether Oranges, when grown from seed fertilised with pollen of the same variety, produce good fruit. As I understand it, they are not propagated generally by seed.

Mr. Webber: So far as the Orange is concerned, Oranges always produce Oranges. Seedlings of the Orange give Oranges; and seedlings of the Pomolo give Pomolo. Crossings of different species seem to be very rare.

The Chairman: You spoke just now about a nucleus fertilising the germ cell, and thereby giving one hybrid plant out of three seedlings, the other two of which represented the female. I should like to know whether you have ever had two representing the male and one the female out of the three.

Mr. Webber: In answering that question it is necessary to bear in mind that in these cases we have differences. In some instances we note supernumerary embryos developing. In the case of Oranges I think they are developed from the cells. In the case of double fecundation the nucleus unites with the two pollen nuclei, which finally produces an endosperm; but secondary embryos are not developed from that endosperm, and, as I understand it, we cannot expect any case of double fecundation.

THE STRUCTURE OF CERTAIN NEW HYBRIDS (PASSIFLORA, ALBUCA, RIBES, BEGONIA, &c.).

By JOHN H. WILSON, D.Sc., F.R.S.E., St. Andrew's University.

THE prediction made by Sabine, in 1820, when describing the first known hybrid Passion-flower,* that "the production of plants of a similar description will probably be great hereafter," has been amply fulfilled. The number of hybrids is now very considerable, and their diversity bewildering. It is not my intention, however, to attempt to describe, or even to compile a new list of, all Passion-flower hybrids. The following notes must necessarily be restricted to an account of my own experiments at St. Andrews, and to the description of the few hybrids I have been able to raise there.

PASSIFLORA BUONAPARTEA × P. CÆRULEA.

My earliest experiment succeeded admirably, it being the application of the pollen of *P. cærulea* to a flower of *P. Buonapartea.*† The fruit held and ripened. A little further out on the same branch another flower received pollen of P. Constance Elliot, a variety of *P. cærulea,* but in this case the fruit fell before it was fully developed. I do not possess exact measurements of the fruit secured, but I understand that it was not so large as the fruit of *P. Buonapartea* when fertilised by its own pollen. It was plump, and contained 370 seeds, the majority of which looked healthy. They were sown in my absence, and their welfare carefully attended to, but only one germinated. I believe that a reasonable time was allowed for others to appear before the soil was thrown out. This solitary seedling grew vigorously, and produced its first flower in May 1892. A figure and description of the new hybrid, under the name P. Margaret Wilson, are given in the *Gardeners' Chronicle,* vol. xxv. 3rd ser., 1899.

Comparison of the hybrid P. Margaret Wilson with its Parents.

The following abbreviations will be used :—

B. = *P. Buonapartea.*
C. = *P. cærulea.*
M.W. = *P.* Margaret Wilson.

STEMS.

The young stem and branches ‡ of B. are stout, tetragonal, winged, light green.

* *Trans. Hort. Soc.* vol. iv. p. 267.

† This Passion-flower is stated to be itself a hybrid between *P. quadrangularis* and *P. alata.* I have had some difficulty in satisfying myself that it is distinct from *P. quadrangularis.* It would seem that there are varieties of the latter in cultivation, some of which are almost identical with *P. Buonapartea.* It may be remarked that *P. alata* and *P. quadrangularis* are often confused in collections and nurseries. Very probably seedlings of both, differing more or less from the types, are often cultivated, and hybrids between them, other than *P. Buonapartea,* may also be grown under specific names.

‡ The description of the microscopic structure of these and other organs is reserved.

In C. they are much less stout, almost cylindrical, with five, sometimes six, well-defined angles, between which are several minor ridges; glaucous green, with a good deal of reddish-purple, which is often confined to the ridges.

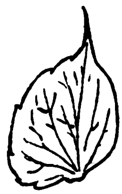
In M.W. the branches are rather stouter than in C. and much more distinctly angular. There are commonly five angles, one of them being less prominent than the rest. The minor ridges are indistinct. Much purple coloration exists.

Stipules.

The stipules of B. (fig. 50) are lanceolate, acuminate, slightly oblique, $\frac{1}{2}$ to $\frac{7}{10}$ in. long, $\frac{1}{4}$ to $\frac{2}{5}$ in. broad, narrowing to the base; the margin almost entire, or very inconspicuously serrate.

In C.* (fig. 52) they are much larger, often more than 1 in. long and $\frac{1}{2}$ in. broad; in form like a cordate leaf halved longitudinally, the apex prolonged into an awn-like point, $\frac{1}{5}$ in. long.

In M.W. (fig. 51) the stipules partake of the characters of those of both parents in a marked way. They are obliquely ovate, dentate



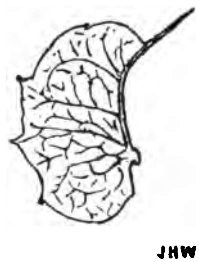


FIG. 50.— P. BUONAPARTEA. FIG. 51.—P. MARGARET WILSON. FIG. 52.—P. CÆRULEA.
STIPULES (nat. size).

on the longer side, acuminate or ending in a sharp point which is usually $\frac{1}{6}$ in. long. The entire length of the stipule is often $\frac{7}{8}$ to 1 in., and the width $\frac{1}{2}$ to $\frac{2}{3}$ in. The largest observed measured $1\frac{1}{2}$ in. long and $1\frac{1}{10}$ in. broad.

Leaf-stalks.

The leaf-stalks of B. (fig. 53) are strong, $1\frac{1}{2}$ to $2\frac{1}{2}$ in. long, having one sharp mesial ridge along the dorsal (under) side continuous with one of the wings of the stem, and a shallow channel on the upper side. The upper edges are interrupted by two pairs of light-green sessile glands, the one pair being placed about $\frac{1}{4}$ in. beneath the base of the lamina, and the other pair nearly half-way between the upper pair and the base of the stalk. The glands are cup-shaped, directed laterally, and in large leaves the orifices may measure $\frac{1}{10}$ in. across.

In C. (fig. 55) the leaf-stalks are sub-cylindrical, flattened on the upper side. They may reach the length of $1\frac{1}{2}$ in., and some red coloration is commonly present. They bear two, three, or four stalked glands, both glands and stalks being dark purplish-green. The stalks are often $\frac{1}{10}$ in. long. Their distribution is rather irregular. When only two are present

* A very careful account of the structure of *P. cærulea* is given by Sabine, assisted by Lindley, *loc. cit.* pp. 262–265.

(the usual number in leaves of average size), they are commonly close to each other, near or below the middle of the leaf-stalk; if three, the third is higher up; if four, they may appear in pairs, one pair being as above described, and the other close to the base of the leaf-blade; or, finally, they may all be at different points on the petiole.

In M.W. (fig. 54) the leaf-stalks are slightly channelled along the

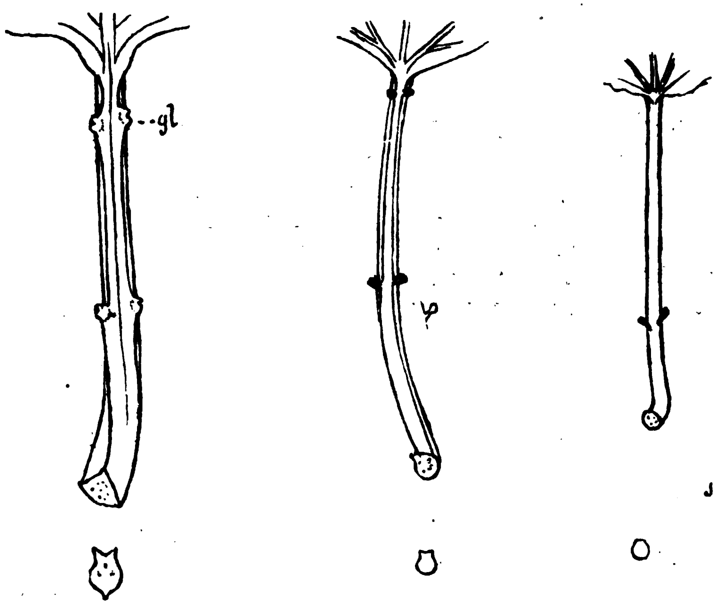


FIG. 53.—P. BUONAPARTEA. FIG. 54.—P. MARGARET WILSON. FIG. 55.—P. CÆRULEA.
LEAF-STALKS (nat. size).

upper side, and rounded on the under side. In large leaves they may reach the length of $2\frac{1}{2}$ in.; a common length is $1\frac{1}{2}$ in. The colour is commonly dull pink. Four glands are present, usually very nearly opposite, in pairs, one pair being placed close up to the base of the lamina, or $\frac{1}{16}$ to $\frac{1}{8}$ in. from it, and the other pair either at the middle of the petiole or a little above or beneath it. The glands are light green, with relatively stout stalks of a darker colour or deeper green.

LEAF-BLADES.

The leaf-blades of B. (fig. 56) are large, ovate-cordate, somewhat acuminate; the upper side dark green, the under side lighter green, not glaucous; the margin entire. The largest example studied was $8\frac{5}{8}$ in. long and $7\frac{1}{4}$ in. broad.

The leaf-blades of C. (fig. 58) are characteristically five-lobed, often seven-lobed by branching of the two lower lobes, occasionally abnormally three-lobed. Examples 5 in. long and $7\frac{3}{8}$ in. wide have been noted. The upper surface is deep green, the under surface glaucous, the veins being often tinged with purple. Minute glands occur at notches on the margins, near the bases of the lobes.

FIG. 56.—LEAF OF P. BUONAPARTEA ($\times \frac{1}{3}$).

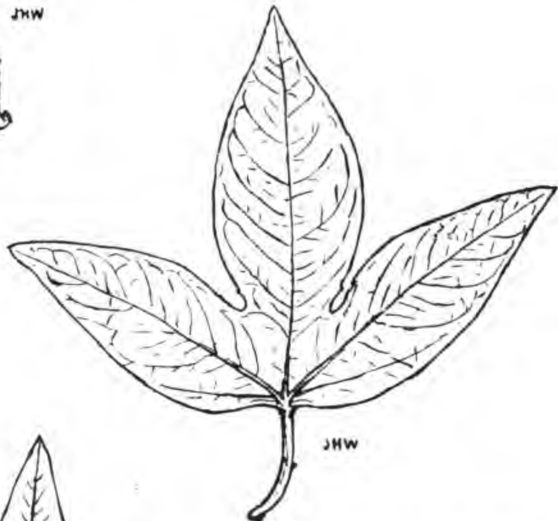


FIG. 57.—LEAF OF P. MARGARET WILSON ($\times \frac{1}{3}$).

FIG. 58.—LEAF OF P. CÆRULEA ($\times \frac{1}{3}$).

In M.W. (fig. 57) the leaf-blades are invariably three-lobed. The length may in very large leaves be 7½ in., and the breadth from tip to tip of the side lobes 10¾ in.; an average length, however, is 5¼ in., and breadth 7½ in. Notches with glands occur between the lobes, ¼ to ½ in. from their base. In younger leaves the veins on the under side are often dingy purple. In older leaves the purple or red colour is variable in distribution and intensity, the variability depending on cultural conditions.

Flowers.

The flowers of B. are commonly borne singly in the axils of consecutive leaves on the young branches, and they tend to hang vertically.

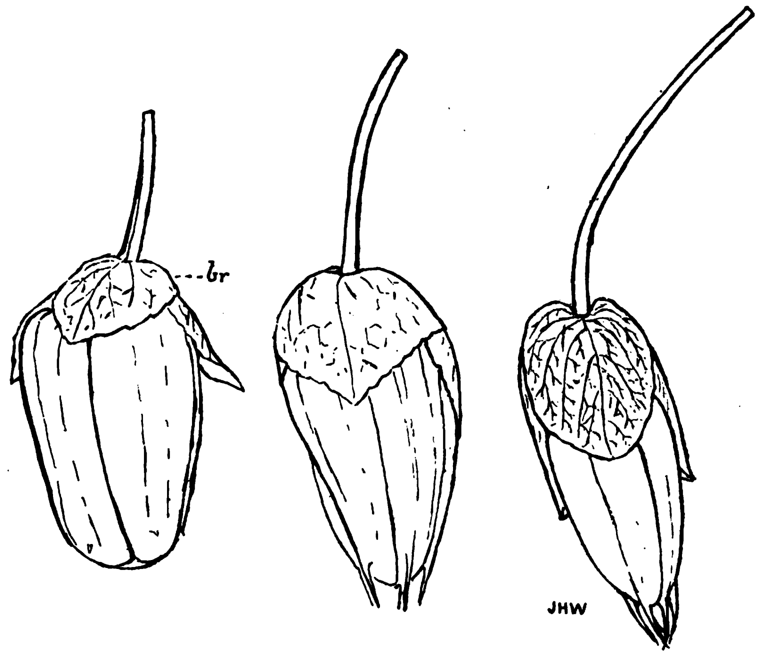


Fig. 59.—P. Buonapartea. Fig. 60.—P. Margaret Wilson. Fig. 61.—P. cærulea.
Flower-buds (nat. size).

The peduncle is triquetrous, 1 in. to 1½ in. long. The odour is strong, and not unpleasant.

In C. the flowers turn upwards to the light by the bending of the long cylindrical peduncle (the longest 3⅛ in.). They are produced singly as in B. The odour is comparatively faint and decidedly unpleasant.

In M.W. the face of the flowers is directed downwards at an angle of about 45° with the horizon. The peduncle is 1¼ in. to 2¼ in. long, and slightly curved outwards, cylindrical at the base and obscurely three-cornered distally. The odour is fairly strong and very pleasant, recalling that of certain Irises. The flowers are borne singly, and continue to be produced for several months.

Occasionally in the hybrid, and in both its parents, the flowers borne at two consecutive nodes open simultaneously.

The bracts of B. (fig. 59, *br*) are cordate, acute, crenate, 1 to $1\frac{1}{4}$ in. long.

In C. (fig. 61) the bracts are large, ovate-cordate, bluntly rounded or subacute, entire or very indistinctly crenulate, 1 to $1\frac{1}{6}$ in. long and $\frac{7}{8}$ to 1 in. wide.

In M.W. (fig. 60) they are large, ovate-cordate, acute, faintly serrate, $1\frac{1}{4}$ to $1\frac{3}{8}$ in. long, 1 to $1\frac{1}{4}$ in. wide.

Sepals.

The sepals of B. are oblong, $1\frac{3}{4}$ to $1\frac{7}{8}$ in. long, 1 to $1\frac{1}{8}$ in. wide at base, the rounded apex extending $\frac{3}{8}$ to $\frac{1}{2}$ in. beyond the short or almost obsolete dorsal mucro. The two outermost sepals are green on the lower surface; the third pink along one margin; the inner two pink on both margins; the upper surface of all is reddish-crimson.

In C. the sepals are oblong, slightly keeled, about $1\frac{1}{2}$ in. in length, with an arista of $\frac{5}{16}$ in. tapering from a vertically expanded base, and rising $\frac{1}{12}$ in. from the apex of the sepal. The upper surface is dull white, with a very faint bluish tinge; the under surface a general light green.

The sepals of M.W. are 2 in. long, and bear a green arista about $\frac{1}{6}$ in. long, $\frac{1}{4}$ in. from the end. The upper side of the sepals is a clear lilac rose, shading off to nearly white at the centre. The colour of the under side is distributed as in B.; the shade, however, is pinkish-purple.

Petals.

The petals of B. are 2 in. long, $\frac{3}{4}$ to $\frac{5}{6}$ in. wide; pink on the under surface and crimson above. The spread of the flower is $4\frac{1}{2}$ to 5 in. The petals and sepals in the fully expanded flower may fall back until they form an angle with the floral axis a few degrees greater than a right angle.

The petals of C. are slightly longer and narrower than the sepals; white, faintly tinged with blue. The diameter of the flower is $3\frac{1}{2}$ to 4 in. In strong sunshine, especially when indoors, the perianth bends back a very considerable distance.

In M.W. the petals are also longer and narrower than the sepals, the upper side a uniform lilac rose, the under side a lighter shade of the same; more or less pouched at the apex. The diameter of the flower is $4\frac{3}{4}$ in. when measured from a petal to a sepal opposite, or $5\frac{1}{8}$ in. when from nearly opposite petals. The petals and sepals may spread out until at 90° with the axis, but they usually lie at a somewhat less angle.

Corona.

In the corona of B. the outer faucial rays (fig. 62, *a*) are in two whorls; the rays of equal length; the average number ninety-three (fifty in outer and forty-three in inner whorl); $2\frac{1}{4}$ in. long; rigid and slightly curved; wavy and delicate at the outer extremity; white at the base, and conspicuously coloured by five or six alternating bands of white and

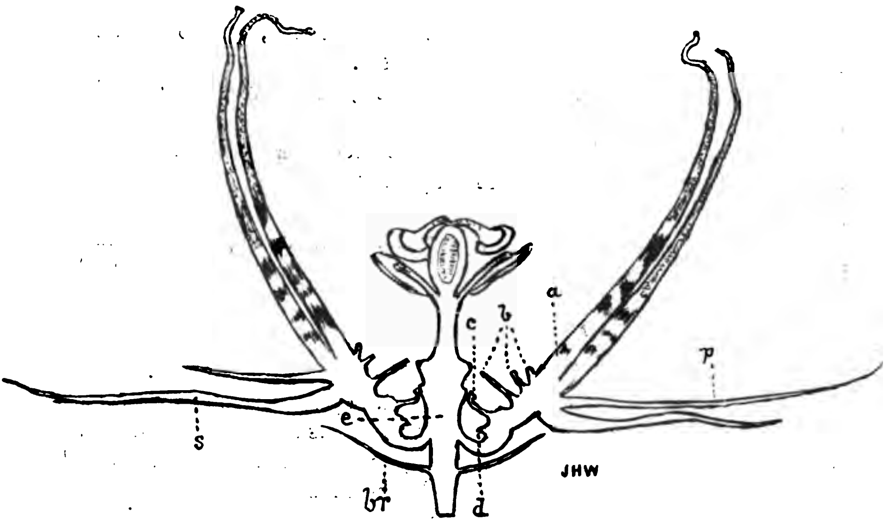


FIG. 62.—SECTION OF FLOWER OF P. BUONAPARTEA (nat. size); *br*, BRACT; *s*, SEPAL; *p*, PETAL; *a*, *b*, *c*, OUTER, SECOND, AND MEDIAN SERIES OF CORONAL APPENDAGES; *d*, ANNULAR RIDGE; *e*, GONOPHORE. (The styles are figured in perspective.)

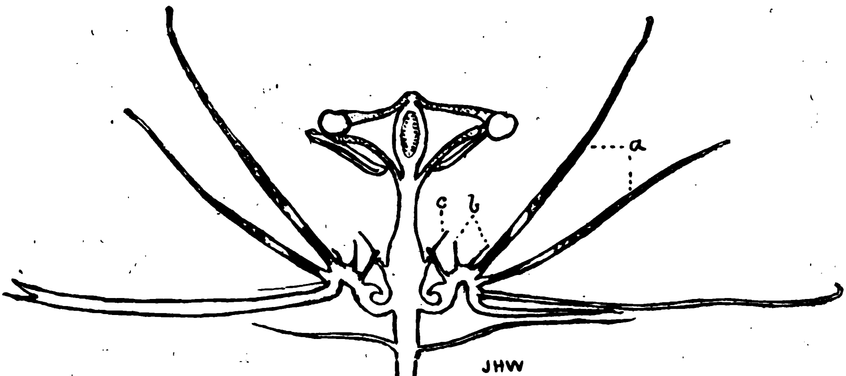


FIG. 63.—SECTION OF FLOWER OF P. MARGARET WILSON (nat. size).

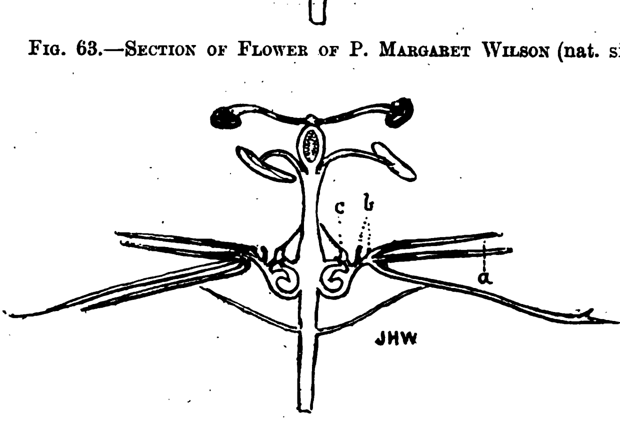


FIG. 64.—SECTION OF FLOWER OF P. CÆRULEA (nat. size).

rich red or purplish-brown, the colours graduating at mid-length into mottled mauve-purple; the tips white, capitate. The rays have a spread of $2\frac{1}{2}$ to 3 in. In bud they are found bent under the petals, and their colour is present at a comparatively early stage of their development. The capitate tips are beset with papillæ, which may be regarded as glandular. It is easy to demonstrate that the odour of the flower has its seat in the rays, for when they are cut off the scent disappears.

The corresponding rays of C. (fig. 64, *a*) are in whorls of a similar character. When fully expanded they lie straight at a right angle to the axis of the flower, or the outer ones a few degrees beyond that angle. The expanse of the rays is a little over 2 in. The rays are $\frac{3}{4}$ in. long; the outer whorl seventy to eighty, and the inner sixty to seventy in number. The base is white, and immediately above it is a band, $\frac{1}{6}$ to $\frac{3}{16}$ in. deep, of rich purple brown, shading upwards into purple, followed suddenly by a white ring $\frac{1}{8}$ in. deep, which merges into a mottled purplish-blue. The apex is white, non-capitate, and destitute of glandular papillæ.

In M.W. the corresponding rays (fig. 63, *a*) are in two whorls, expanding well out ($3\frac{1}{4}$ to $3\frac{1}{2}$ in.). They are about ninety in number, the outer whorl having about five more than the inner. The largest numbers met with were $50+45=95$. The length of the inner rays is $1\frac{5}{8}$ in., the outer rays $1\frac{1}{2}$ in. The basal $\frac{1}{4}$ in. is deep purplish-brown, shading quickly into a band of pure white $\frac{1}{8}$ in. deep; beyond this is a narrow band of dark greyish-blue, then a very narrow band of pure white, followed by a dark mauve-purple band ($\frac{1}{16}$ in. deep), which shades into a lighter tint, and that colour extends throughout the distal half of the rays. The tips are white and beset with papillæ, which are much less conspicuous than those of B., and are often absent in the outer whorl.

The second faucial series of coronal appendages of B. (fig. 62, *b*) consists of (1) an irregular whorl of white, red-tipped, short projections close to the base of the inner whorl of long rays; (2) a more regular whorl of similar projections; and (3) a whorl of appendages, $\frac{1}{4}$ in. long, occasionally occurring as single filaments, but more commonly united in their basal halves into small groups, bearing three to four concentric bands of red, and tipped with brown purple.

In C. this series of organs consists (fig. 64, *b*) of a circle of short thin rays, with very dark-coloured tips. A few black-tipped protuberances are found irregularly distributed in the region between the circle just described and the bases of the long rays.

In M.W. the corresponding series comprises (fig. 63, *b*) a distinct circle of very deep brown-purple rays $\frac{1}{6}$ in. long, almost straight, or slightly curved outwards; and, external to these, numerous alternately disposed, mostly shorter, dark-coloured protuberances, situated close to the base of the inner long rays and lying parallel with them. Occasionally some of the protuberances described may be found so far displaced inwards as to give the appearance of a double whorl of short rays when seen in a section of the flower.

The inner or median series in B. is represented (fig. 62, *c*) by a flat white membranous canopy completely covering in the nectary. The free inner red-dotted edge curves upwards close to the gonophore.

The corresponding series in C. (fig. 64, *c*) forms a more complicated structure. Studied from the base upwards, it presents the following parts: a basal membranous portion which helps to cover in the nectary; a cushion-like expansion placed in close proximity to a projecting ledge of the gonophore; and a fringe of short delicate red-brown rays which lean towards and surround the axis.

In M.W. this series (fig. 63, *c*) forms a membranous tube which inclines inwards until it approaches very closely to a cup-like projection of the gonophore, and from the upper edge of the membranous part there arises a circlet of almost black filaments, $\frac{1}{8}$ in. long and directed away from the axis. A slightly developed cushion projects inwards from the top of the membranous tube.

In B. an annular ridge (fig. 62, *d*) somewhat incurved downwards, projects into the closed cavity and forms part of the nectary.

In C. a corresponding ridge occurs, and occupies relatively more space in the cavity.

In M.W. a similar structure is present, but it exhibits no peculiar feature. The nectar is copious.

Gonophore.

The gonophore of B. (fig. 62, *e*) is massive, girt in the lower half by two low ledges, and narrowed very abruptly into a cylindrical shaft which bears the stamens and pistil. The lower part is white, and the narrowed shaft dotted with red.

In C. the base of the gonophore is stout and expands, $\frac{1}{10}$ in. up, into a flattened collar or ledge. This structure is directed upwards a little, and widens at its outer edge into a rim which fits the cushion-like enlargement of the inner coronal appendage already described. The shaft narrows a little upwards, above the ledge, and is very pale green, without spots.

In M.W. the gonophore dilates, $\frac{1}{8}$ in. from the base, to form a cupulate ledge, the margin of which lies in close proximity to the cushion at the top of the membranous coronal tube. The shaft tapers upwards gradually and considerably. Its base is thickly and regularly dotted with elongated red spots, and the upper part is white, with a few dots.

Stamens.

The filaments of B. are flat, light green, thickly spotted with red on both upper and under surfaces. The anthers are large and bear plentiful yellow pollen, the proportion of normal grains being high.

In C. the upper side of the filaments is thickly dotted with faint red spots. The pollen is golden-yellow and very copious.

In M.W. the filaments are very uniformly dotted with red on both sides. The anthers are normal in form and size, but, when they dehisce, instead of being loaded with pollen, as those of the parents are, the faces are covered with a glutinous, dull yellow exudation. In many cases undeveloped and shrivelled pollen grains are found embedded in this substance, and not seldom the grains are sufficiently well developed to give a brighter yellow colour to the anthers. The best examples of pollen, however, are probably never quite normal.*

* *Cf.* Masters, *Veg. Teratology*, p. 463.

Pistil.

The styles of B. are ½ in. long, chalky white, with a reddish tinge and a few faint pink spots at the base. The stigmata are of a pale cream or grey colour.

In C. the styles are ⅜ in. long; the ground colour very light greyish or purplish green, dotted throughout with comparatively large reddish-purple spots. The stigmata are dull greenish-drab.

In M.W. the styles are ½ in. long, with deep purple spots on a light purple ground; the stigmata purplish-drab. The ovary is elliptical, ⅝ in. long, and fairly intermediate in character between that of B. and of C.

Potency of Pollen of P. Buonapartea.

There is good reason to believe, from the results of a few experiments carried out several years ago, that the flowers of *P. Buonapartea* can be fertilised by their own pollen; and evidence is not wanting that one flower can be fertilised by the pollen of another.* Its potency has been further made manifest, the flowers of the species *P. alba* having been fertilised by it (p. 159). Moreover, experiments in progress point to its being as potent as that of *P. quadrangularis* and *P. alata* in fertilising (imperfectly) its own hybrid offspring, *P. alba* × *P. Buonapartea* (p. 163).

Seedlings of P. Buonapartea.

On one occasion, as the result of accidental fertilisation, a fruit was borne on my plant of *P. Buonapartea*. The fruit was oval, measuring 4½ in. long and 2½ in. broad. Only thirty-four of the very numerous seeds seemed good. Twelve of the best were sown, and seven of them germinated. Some of the seedlings were much more vigorous than others, and very considerable diversity existed amongst them in leaf form. One, at least, had distinctly narrower leaves. No opportunity, however, was afforded of studying and comparing them in vigorous development. Little more, therefore, could be gathered than that there seemed to be a marked tendency in certain of the seedlings to produce leaves of a form which perhaps was ancestral.

Experiments in Cross-fertilisation.†

Many attempts have been made to fertilise the flowers of M.W. with the pollen of other Passion-flowers. The following is an enumeration of the resulting failures and partial successes:—

Passion-flowers supplying pollen	Failure	Partial success
P. alata	8	0
P. alba	13	0
P. Buonapartea	5	0
P. cærula	4	12
P. Constance Elliot	12	5
P. Decaisneana	1	0
P. edulis	11	0
P. quadrangularis	2	0
P. suberosa	2	0
Tacsonia Van Volxemi	13	0

* *Gardeners' Chronicle*, vol. xxiv. 1885, p. 181.

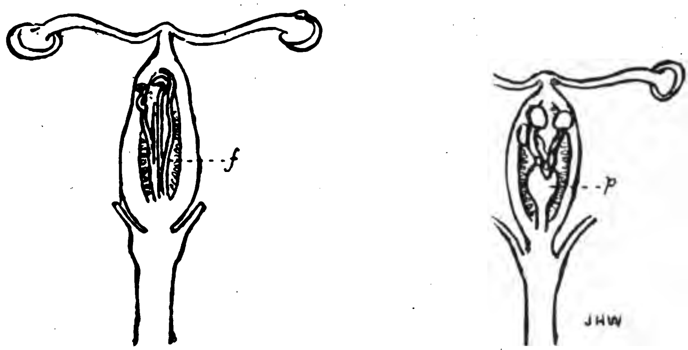
† *Cf.* Darwin, *Animals and Plants under Domestication*, vol. ii. p. 137.

The pollen of *P. cærulea* (the male parent of the hybrid), and of its variety, P. Constance Elliot, alone exercised sufficient potency to cause swelling of the ovary. The maximum length of the fruit, due to fertilisation by pollen of *P. cærulea*, was $1\frac{1}{2}$ in., and the largest fruit by pollen of P. Constance Elliot was $1\frac{5}{12}$ in. long and $\frac{5}{8}$ in. at widest part, with walls $\frac{1}{4}$ in. thick. These dimensions were reached in a few days, and they are far below what a fruit of the hybrid would attain to if fertilisation were complete. In no case was any indication of development of the ovules seen.

Some success with the pollen of *P. Buonapartea* (the seed parent of the hybrid) might have been looked for.

Although the pollen of M.W. itself was obviously very abnormal, it was thought desirable to experiment with it. Accordingly eight flowers received pollen from their own anthers, and seven from the anthers of other flowers of the same plant. As was to be expected, the result was a negative one in every case.

While the failures above described are attributable for the most part to causes not understood, one remarkable teratological feature, which is



FIGS. 65, 66.—OVARIAN PROLIFICATION: *f*, FILAMENTS; *p*, MINIATURE PISTIL (both figs. × 2).

no doubt sufficient to constitute a barrier to successful fertilisation, has been discovered.* The ovaries of certain flowers of the hybrid, displaying no abnormal external features, have been found to enclose peculiar structures. In some there arises from the base (fig. 65, *f*) a group of minute filaments, commonly five in number, closely resembling in form and bright coloration the outer coronal rays. When longer than the cavity containing them, as they often are, the apical portions are curled in irregularly. In other cases a miniature pistil (fig. 66, *p*) occupies the same position, the characteristic colours being well developed. Occasionally a few minute rays are found round the miniature gynophore. Examples are met with in which these abnormal structures are represented by mere rudiments. The ovules in ovaries so invaded do not seem to differ in any way from those in the more normal flowers.

The earliest flowers were most prone to ovarian prolification; indeed, it was almost universal at the beginning of the flowering season. In the latest flowers the reverse condition was equally marked. As affording

* *Vide* Masters, *op. cit.* p. 181.

an indication of the state of matters in mid-season, investigation of the ovaries of fifteen flowers, on June 15, 1899, showed that six were normal, three had rudimentary structures, two had blue filaments, and four had miniature pistils; that is, nine exhibited prolification and six did not. On June 28, eight flowers, and on July 7, eighteen flowers, were studied, and all found to be normal; on July 8, however, twenty, and on Sept. 4, sixteen, were examined, and of these one and two respectively were abnormal.

The latter observations show that the abnormality may not entirely disappear as the season advances. It is very obvious that the development of the monstrosities described is intimately associated with the vegetative vigour of the plant.

Opportunity was not afforded of noting their presence or absence in the majority of the flowers experimented with; but looking to the fact that after a certain date the flowers were mostly normal (that is, did not show ovarian peculiarities), and taking into account a number of observations actually made on ovaries which failed to swell after pollination, it is safe to surmise that fertilisation of the hybrid by any of the Passion-flowers mentioned, except *P. cærulea* and P. Constance Elliot, is unlikely to happen under any circumstances.

PASSIFLORA ALBA.

This species being a parent of the three hybrids yet to be described, it is necessary to give a detailed account of its structure.

P. alba is an extremely rampant-growing species. The vegetative organs present a characteristic light glaucous green colour.

The young stems and branches are cylindrical, very smooth, coated with glaucous bloom, and either partially or quite filled with pure white pith.

The stipules (fig. 68) are very large, examples 2½ in. long and 1¼ in. broad being met with. They are foliaceous, soft, obliquely lanceolate, auricled, apiculate, recurved, with distinct mid-rib, but no radiating minor veins. The apex bears a mucro $\frac{1}{16}$ in. long, terminated by a gland. The auricles overlap and embrace the stem.

The leaf-stalks (fig. 71) are almost cylindrical towards the base, and very slightly flattened in the distal part. They may in large leaves attain the length of 3¼ in., or a little more. The glands are very irregularly disposed. Four is the common number, and they are usually placed in the basal half of the petiole, and well up on the upper side; seldom in opposite pairs, but most commonly alternating irregularly; often only three, occasionally six. The stalk of the gland is bluish, curved, and about $\frac{1}{20}$ in. long; the gland green.

The leaf-blade is trilobed, the texture soft, thin, the largest measuring 6 in. long and 6¼ in. broad; a good average size, however, is considerably smaller. Single notches, sometimes two, with glands, occur between the lobes a short distance from their base. The leaves when bruised emit a very unpleasant odour.

The peduncle is 2 to 2½ in. long; fine, cylindrical, thickening out-

wardly, often bending up suddenly at the outer end until at 90 degrees or more to the general direction, thus bringing the flower into a more or less erect position. The flowers are scentless. The bracts are $\frac{3}{4}$ in. long, $\frac{1}{2}$ in. broad, cordate-lanceolate, auricled, with either one or two glandular teeth at the base.

The sepals in the fully open flower (fig. 74) fall far back. They are soft in texture, the upper side white, slightly tinged with light green, the under side all green, or with one or both margins white; bearing scimitar-shaped processes, arising $\frac{1}{6}$ in. from the end, the longest ($\frac{1}{2}$ to $\frac{9}{16}$ in.), occurring on the lowest sepals.

The petals are white, thin, 1 in. long, about $\frac{1}{2}$ in. wide, greatly reclinate in the open flower. In the corona the outer faucial rays (fig. 74, *a*) are in two whorls, the external rays, about sixty-five in number, $\frac{2}{3}$ in. long, pure white and bent downwards; the internal rays, about $\frac{3}{8}$ in. long, pure white, capitate, also curving downwards, and often intermingling with the external ones.

The second faucial series (fig. 74, *b*) consists of two or three whorls of extremely fine, white, capitate threads, $\frac{3}{16}$ in. long, the innermost nearly erect, and the outer ones radiating outwards.

The inner or median series (fig. 74, *c*) forms a membranous funnel-shaped tube narrowing upwards, the upper edge cut up into an irregular white fringe, the minute clavate branches of which project inwards and approach the fringed edge of the cupulate collar of the gonophore.

The incurved annular ridge in the tube of the flower is similar to that already described in other Passion-flowers.

The gonophore is broad at the base, and a short distance up it bears a fringed cupulate outgrowth which is divided into five parts by incisions of the margin. The shaft above narrows gradually upwards, its colour greenish-white.

The filaments are light green, the anthers $\frac{1}{4}$ in. long, the pollen deep yellow, very copious.

The ovary is deep glaucous green, the styles light green, $\frac{1}{2}$ in. long; the stigmata very pale bluish-green.

All the earliest flowers to open in 1899, to the number of at least six, on a strong plant, bore a four-rayed pistil. Afterwards the normal three-rayed form appeared, and became gradually more numerously represented than the former, as is shown in the subjoined table:—

	June 10th	12th	13th	15th	16th	17th	19th	21st	22nd	23rd	Aug. 7th
Four-rayed pistils .	4	4	3	7	6	5	4	2	5	6	8
Three-rayed pistils .	3	3	2	6	8	12	8	11	13	11	24

Many flowers are self-fertilised. The stigmatic rays, erect in the bud, become depressed in the open flower, and the side of one of the stigmata comes in contact with the edge of the adjacent anther, and thus receives pollen sufficient to effect complete fertilisation. When there are four rays, two of them occasionally receive pollen in this way. On August 8, 1899, thirty-eight self-set fruits of all sizes were counted on one large plant.

Pollen of one flower when applied to another is also quite effectual.

The fruit ripens in ten to twelve weeks after fertilisation. Good

examples measure $2\frac{1}{4}$ to $2\frac{3}{10}$ in. long. They are light yellowish-green, and rather pleasantly scented. The outer wall, beneath the somewhat tough, green, easily separable skin, is $\frac{1}{8}$ to $\frac{1}{5}$ in. thick, and is white, soft, and spongy. From it pass numerous soft threads, once or twice branched, connecting the outer wall with the thin membranous sac which bears the placentas internally. The greatest numbers of seeds found were 258 and 232, the former in a fruit resulting from fertilisation by pollen of another flower of the same plant, and the latter in a self-set fruit. The seeds are elliptical, $\frac{3}{16}$ in. long, black, and obscurely pitted. The viscid yellowish fluid which accompanies them is bitter and unpleasant to the taste, and gives a disagreeable odour to the fruit when it is opened.

Comparatively few experiments in cross-fertilising this species have been carried out. Success followed pollination by *P. Buonapartea* and *P. edulis* respectively (*infra*, p. 165). The application of pollen of P. Constance Elliot has led to variable results. As an outcome of experiments in 1896, the fruit in one case developed fairly well, and bore numerous immature seeds; in another, a somewhat nearer approach to success was reached; in a third, a fully developed fruit was obtained, containing 180 seeds of all sizes, but only three or four appeared to be normal. A fourth swelled rapidly, and promised well, but was accidentally broken off when nine days old.

During the present season (1899) a good fruit was obtained by the same cross. It contained 200 seeds, all more or less badly developed, except one which alone was embedded in yellow fluid, and possessed the very deep brown colour characteristic of a healthy condition. All the seeds were sown, but only one—the good one—has germinated. The seedling, still young, appears to have a vigorous constitution. It bears a close resemblance to the plants of the reciprocal cross, P. Constance Elliot × *P. alba* (p. 166) when these were of corresponding age. It is interesting to note that the pistil of the flower fertilised ~~was~~ four-rayed, and that the fruit secured possessed four, instead of three, placentas.

The additional organs are doubtless due to the splitting of one of the normal three. The numbers of seeds borne by the four placentas of a self-set fruit of *P. alba* bear out this hypothesis, these being 65, 76, 22, 39. The total of the two latter numbers represents a good average number for one placenta.

The application of the pollen of Tacsonia Van Volxemi unexpectedly caused the ovary to swell to a length of $\frac{5}{8}$ in., but no further development ensued.

No swelling took place when pollen of the following Passion-flowers was used: P. Decaisneana (4 experiments), P. suberosa (2), and P. Watsoniana (2).

PASSIFLORA ALBA × P. BUONAPARTEA.

An experiment in crossing *P. alba* by *P. Buonapartea*, carried out in June 1896, proved successful. The fruit ten weeks after fertilisation was so ripe that a very light touch caused it to fall. It was of good size, and in general structure did not differ from the fruit of *P. alba*, as described above. The placentas bore respectively 24, 24, and 25 good

seeds, and 3, 6, and 4 poorly developed ones, the total number being 86. The good seeds were dark purplish, almost black, pitted, $\frac{1}{5}$ in. long Sixty-seven were sown, and 21 germinated.

Great variation was observable in the seedlings, in respect of habit and vigour. One of them was from the first much stronger than the others. All were characterised by having a more or less marked tendency to develop yellow variegation in the leaves. Several had very delicate stems, and a number succumbed during the first winter, leaving three or four of sufficient vigour to justify their being planted out in a greenhouse. In that position they at first made good growth, but one after another died before reaching the flowering stage, until the robust one, referred to

FIG. 67.—PASSIFLORA ST. RULE (nat. size).

above, alone was left. Unfortunately, very few notes were kept of those that died. They differed very materially among themselves in regard to the size of their leaves. With one exception, they resembled the surviving plant in the leaves being three-lobed. In the exceptional case elliptical leaves alone were produced, but perhaps this may have been due to the retention for a longer period than usual of a form very commonly found in Passion-flower seedlings. In one of the seedlings the yellow variegation was very ornamental.

PASSIFLORA ST. RULE.

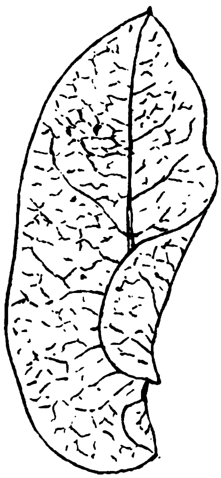
The last survivor, now named P. St. Rule, is a very strong-growing plant, with rather loose branching habit and extremely luxuriant foliage.

The young stems and branches are five-angled, one of the angles being more obtuse than the others. The younger branches are full of pure-white pith, or more or less hollow; slightly glaucous, the side exposed to the sun often reddish.

The stipules (fig. 69) are obliquely lanceolate, apiculate, serrate on the longer side, the teeth distinctly glandular; the largest $1\frac{1}{16}$ in. long, and $\frac{9}{16}$ in. wide.

The leaf-stalk (fig. 72) is $1\frac{1}{2}$ to 3 in. long, nearly cylindrical, flat on the top, the ridges obscure. The petiolar glands are large, sessile, grey, very often five in number, irregularly distributed, pretty often two of them being paired. Four or six glands are of fairly common occurrence, the former being often in pairs—one pair above and the other beneath the middle of the petiole.

The leaf-blades are always tri-lobed, the largest example 6 in. long and 7 in. wide, bright green above, light bluish-green underneath; the



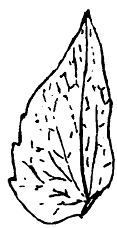


FIG. 68.—P. ALBA. FIG. 69.—P. ST. RULE. FIG. 70.—P. BUONAPARTEA.
STIPULES (nat. size).

middle lobe with usually one, sometimes two, obscure notches $\frac{1}{4}$ to $\frac{1}{2}$ in. from the base.

The peduncle is 1 in. long, sub-cylindrical, curved upwards a little, and so directed as commonly to bring the face of the flower into a vertical position, or give it a slight tilt upwards.

The bracts are $\frac{7}{8}$ to 1 in. long, $\frac{5}{8}$ to $\frac{3}{4}$ in. wide; ovate-cordate, serrate, with actively secreting glandular teeth.

The flowers are as a rule produced singly on individual branches, but very often in pairs, one in each of two neighbouring nodes. They are (figs. 67 and 75) 3 in. in diameter, exclusive of the aristæ of the sepals. The odour is Iris-like, faint and pleasant, resembling that of P. Margaret Wilson.

The sepals are $1\frac{3}{8}$ in. long, $\frac{7}{12}$ in. broad at base; in fully open flowers bent back 25° to 30° below the horizontal, and causing the bracts to be folded back above the middle; thick, with spongy texture, the lower side

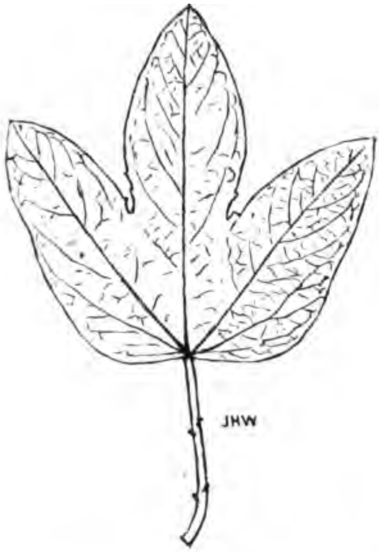


FIG. 71.—LEAF OF P. ALBA (× $\frac{1}{3}$).

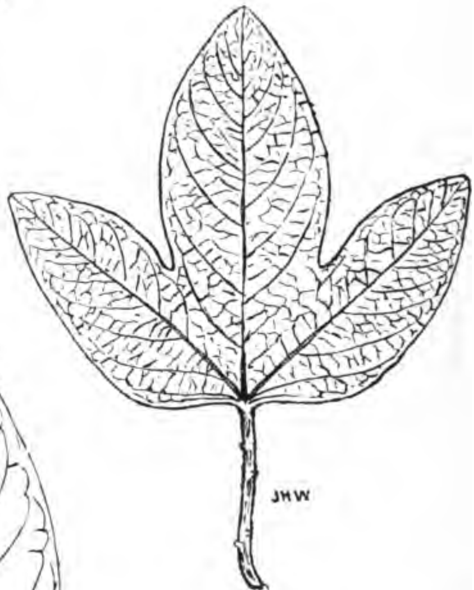


FIG. 72.—LEAF OF P. ST. RULE (× $\frac{1}{3}$).

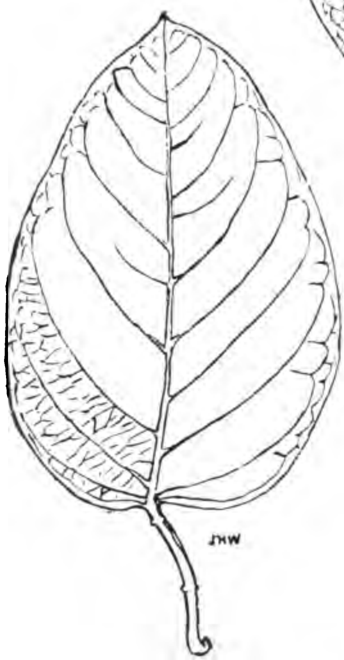


FIG. 73.—LEAF OF P. BUONAPARTEA (× $\frac{1}{3}$).

bright green or with one or both margins lilac-rose-coloured, according to position in bud, the upper side light lilac-rose; the falcate process of the lowest sepal $\frac{3}{8}$ in. long, that of the highest $\frac{1}{6}$ in.

The petals are $1\frac{1}{4}$ in. long, $\frac{1}{2}$ in. broad, narrow and white at the base, delicate rose-purple above, paler beneath; reflexed 15° to 20° beneath the horizontal plane.

The outer coronal rays (fig. 75, *a*) are in two whorls, directed 10° to 20° above the horizontal, with an expansion of $2\frac{1}{2}$ in.; commonly seventy-three in number (outer thirty-eight, inner thirty-five), the rays in both whorls 1 in. long, almost straight, with the apical portion ($\frac{1}{8}$ to $\frac{3}{16}$ in.) flexuous; the basal $\frac{1}{8}$ in. white, succeeded in the inner rays by three, and in the outer by four, purple bands alternating with white; the outer half-length bright mauve, tipped with white.

The second series (fig. 75, *b*) is in three (in some cases reduced to two) whorls, the external rays $\frac{1}{8}$ in. long, rising close to the base of the inner rays of the outer series, and lying nearly parallel with them; the internal rays $\frac{1}{4}$ in. long, almost erect, or leaning towards the gonophore.

The median series (fig. 75, *c*) forms a white, tent-like roof to the nectary, the upper part in close proximity to the gonophore, and bending upwards as a fringe composed of forked, somewhat clavate, filaments, $\frac{1}{12}$ in. long, dotted with light purple. Very short purple-spotted knobs rise in a circle on the inside of the bend, and lie in contact with the ledge of the gonophore. The annular ridge is usually very slightly incurved, the nectar plentiful.

The gonophore is cylindrical in the lower portion, and at $\frac{1}{4}$ in. from the base bears a small ledge which is either cupulate or sinuous. The shaft above is rather slender, the lower portion white, the upper portion green with very faint purple spots.

The filaments are dull green, faintly spotted with purple on both sides. The anthers are invariably abnormal, hanging vertically, fleshy, indehiscent, and colourless, except for a little yellow colour shining through the transparent walls and indicating the presence of a little very poorly developed pollen.

The ovary is light green, relatively large and thick-walled; the styles $\frac{1}{2}$ in. long, massive, straight, very pale green with dull purple at the base; the stigmata large, light green. No abnormality of the ovary has ever been observed.

The following experiments in pollinating P. St. Rule have been carried out:—

Passion-flowers supplying pollen	Failure	Partial success
P. alata	0	10
P. alba	2	3
P. Buonapartea	1	5
P. cærulea	9	4
P. Constance Elliot	5	5
P. edulis	11	0
P. Decaisneana	1	1
P. Impératrice Eugénie	1	0
P. quadrangularis	0	2
P. suberosa	2	0
P. Watsoniana	1	0
Tacsonia Van Volxemi	5	0

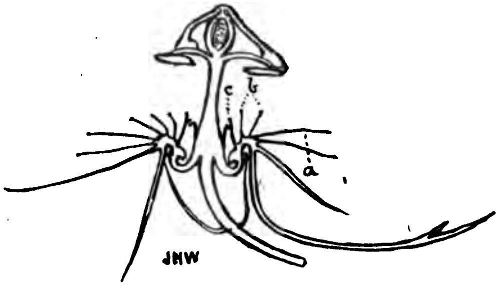


FIG 74.—SECTION OF FLOWER OF P. ALBA (nat. size).

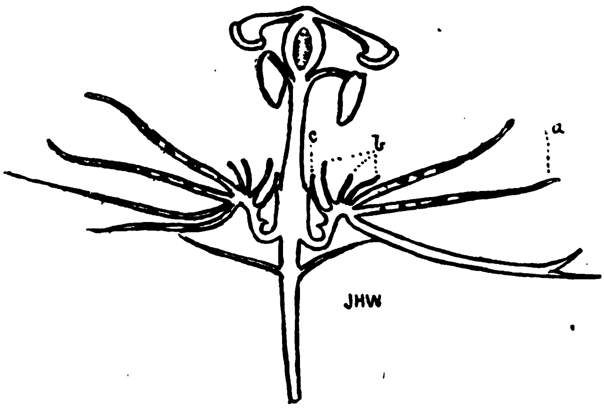


FIG. 75.—SECTION OF FLOWER OF P. ST. RULE (nat. size).

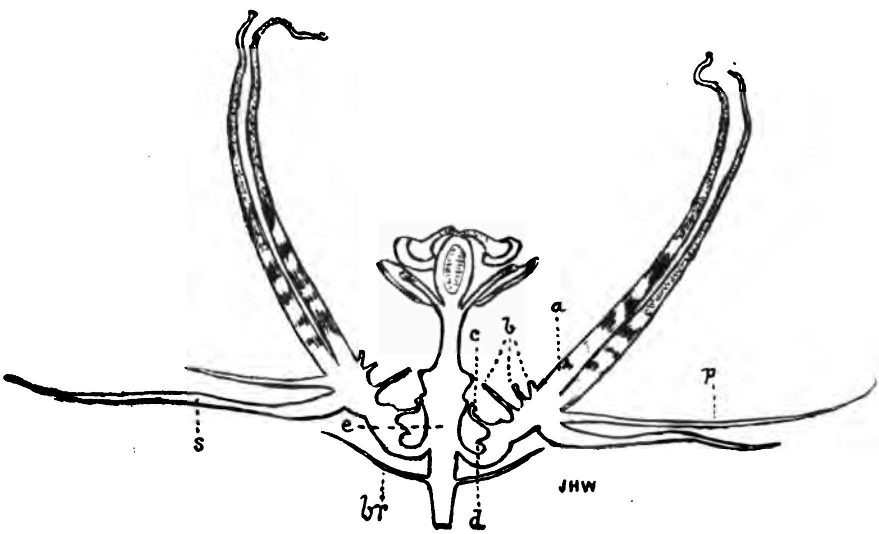


FIG. 76.—SECTION OF FLOWER OF P. BUONAPARTEA (nat. size).

It is not a little surprising to find so great a measure of success as is set forth in the above table. The most noteworthy results were secured by the use of pollen of *P. alata.* The ten fruits swelled rapidly, several attaining the length of $1\frac{1}{2}$ in. within six days, and $2\frac{1}{2}$ in. within thirteen days. The smallest fruit collapsed on the fourteenth day, when $1\frac{3}{4}$ in. long. It contained three seeds, arrested in process of development. The next in point of size, $2\frac{1}{8}$ in. long, failed on the nineteenth day. The remaining fruits are larger, and give promise of yielding better seed. The two largest measure respectively, at the moment of writing, $2\frac{5}{8}$ in. and $2\frac{3}{4}$ in. in length. Externally they present unmistakable blending of the characters of the fruits of the parents, *P. alba* and *P. Buonapartea.* The internal structure, seen in the examples which have swelled to some size before falling, also bears this out, the characters of *P. alba* being perhaps rather the more evident.*

The two fruits resulting from pollination by *P. quadrangularis* reached the length of $2\frac{3}{8}$ in. before falling. They contained a few seeds which had developed a little.

The fruits due to fertilisation by pollen of *P. Buonapartea* are still young. The failure recorded may well have been due to the pollen having been kept four or five days.†

The partial success by pollen of *P. Decaisneana* (*P. alata* × *P. quadrangularis*) was represented by a fruit which fell when $\frac{1}{2}$ in. long.

Of the three fruits due to fertilisation by *P. alba,* the largest measured $2\frac{1}{3}$ in. long, and contained when it fell, four weeks old, the remains of seven poorly developed seeds. The second fruit was 2 in. in length when it fell, and the third fell early.

The largest fruit resulting from the application of the pollen of *P. cærulea* measured $2\frac{1}{4}$ in. in length, and contained four half-developed seeds. The best example obtained, by pollen of P. Constance Elliot, reached a very considerable size, being $2\frac{3}{8}$ in. in length, and well formed. It was, however, quite empty. Another, 2 in. in length, contained four young seeds.

PASSIFLORA ALBA × P. EDULIS.

This hybrid was secured by an experiment carried out on September 1, 1898. The fully ripe fruit fell when lightly touched, on February 4, 1899, after having hung for a considerable time during the winter without showing signs of complete ripeness. It bore all the characters of a well-developed fruit of *P. alba* fertilised by its own pollen. It was $2\frac{3}{8}$ in. long, and contained 238 seeds, which were

* Opportunity has been afforded of making a few further observations on the fruits resulting from fertilisation by *P. alata.* Three of these were found hanging fourteen weeks after pollination. They presented a deceptively fresh appearance, being green and only slightly shrivelled. The largest measured 3 in. in length. When opened they were all found to contain nothing except flat, dry, brownish rudiments of seeds, borne for the most part in the apical half of the ovary. The total numbers of these in the fruits were respectively seventy-four, sixty-three, and fifty-one.

† A fruit of this series was also found to have hung fourteen weeks in a fairly fresh state. It measured 3 in. in length, and contained twenty-four rudimentary seeds. No good seed has been produced in any of the fruits borne by P. St. Rule.

evidently all good. On February 7, 210 of these were sown. Their germination was very slow and unequal, there being a considerable interval of time between the appearance of the first and the last of sixteen seedlings now above ground. The first to germinate died very soon, but another took the lead and grew far ahead of the rest, being at the time of writing 12 in. in height, with fifteen leaves, while the others vary from 4 in. to $\frac{3}{4}$ in. in height, with only a few young leaves.

The strongest plant is still too young to admit of comparative description. The leaves, with the exception of two young oval ones, are three-lobed, a form which seems likely to persist. As a rule two glands occur close together, a little above the mid-length of the petiole. In *P. edulis* the leaves are three-lobed, with a pair of petiolar glands close to the leaf blade.

Much golden variegation existed in the earlier leaves of this seedling, and is a striking feature in all the other seedlings. It may be recalled (p. 160) that this condition, indicating constitutional weakness, obtained in the hybrids of which P. St. Rule is the survivor, and which also had *P. alba* as their seed parent.

PASSIFLORA CONSTANCE ELLIOT × P. ALBA.

This cross was effected in the beginning of September 1898, and the ripe fruit was gathered in the end of November. The fruit was oval, $1\frac{3}{4}$ in. long, orange in colour, and full of deep-red pulp. The good seeds, 189 in number, were $\frac{1}{6}$ to $\frac{3}{16}$ in. lóng, black, and pitted. Besides these, forty undeveloped ones were counted. On February 1, 1899, 170 seeds were sown, and in six weeks it was found that 144 had germinated. The seedlings bore a most marked resemblance to each other; and in the limited number kept for cultivation the similarity continues to be so great as to defy distinction. They have made very vigorous growth, but it is hardly to be expected that they will flower this season.

The great majority of the very earliest leaves presented a three-lobed form. The adult form, having narrower lobes, was reached at about the twelfth leaf. Very soon five-lobed leaves appeared in an irregular fashion among the three-lobed ones; and at the present time it is impossible to say which form will ultimately predominate. The former are derived from the latter by the lobing of the margin, and by the radiating veins, seen near the lower edge of the lateral lobes, becoming the mid-veins of the new lobes. Asymmetrical transition forms with four lobes occur here and there.

The largest leaves at present are three-lobed ones (fig. 77). The petiole is cylindrical, $1\frac{1}{5}$ to $1\frac{3}{8}$ in. long, most commonly bearing one pair of stalked glands close together near its mid-length. The stalks of the glands measure $\frac{1}{20}$ in. in length. Three glands are often present, sometimes four. The blade of the leaf is $2\frac{3}{4}$ to $3\frac{5}{16}$ in. long and $3\frac{1}{2}$ to $4\frac{3}{5}$ in. broad. Three conspicuous glands on short pedicels, directed backward, occur on each side of the middle lobe near its base, and two glands of a similar kind occur on the lateral lobes, and correspond in position to the lower two on the middle lobe. Other marginal glands in the leaves of this hybrid (as in other Passion-flowers) are indicated by the presence

of secretion, the organs themselves being often difficult to detect by the naked eye.

The stipules resemble those of the female parent considerably, but are not so markedly one-sided, and the apical point is not nearly so long. On the whole, the characters of the hybrid, as represented by the vegetative organs, have a greater leaning to that parent than to the other, *P. alba*.

For purposes of comparison it should be stated that the plant of

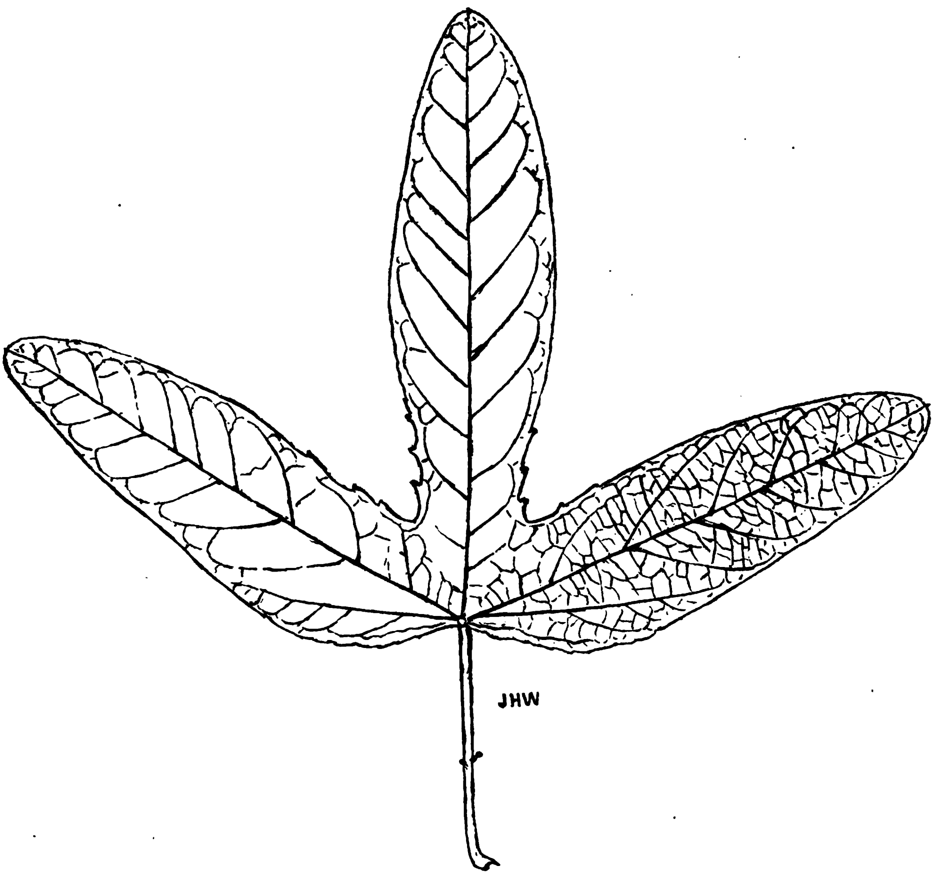


FIG. 77.—THREE-LOBED LEAF OF P. CONSTANCE ELLIOT × P. ALBA (nat. size)

P. Constance Elliot, used as the seed parent, bears a very much larger proportion of seven-lobed leaves than is borne on the plants of *P. cærulea* grown at St. Andrews, and the lobes are distinctly narrower. The additional lobes, however, are to be regarded simply as outgrowths or branches of the two lowest of the five lobes in the more typical leaf.

RIBES NIGRUM × R. GROSSULARIA.

(*Ribes nigro-grossularia.*)

At one time it was thought impossible to effect a cross between the Black Currant and Gooseberry. This has, however, been done by at least three hybridists. The first to succeed was probably C. J. Burnett, Esq., Old Aberdeen. This skilful experimenter informs me that more than twenty years ago he had proceeded so far as to have a number of young crossed seedlings growing in his garden; but the hoe, used indiscriminately, closed their career before they had developed their distinctive characters. Ten or twelve years ago Mr. Burnett renewed his efforts, and secured several undoubted hybrids, three of which are still grown by him. In the former as well as in the latter series the Black Currant was the seed parent.

Very shortly after Mr. Burnett's first experiments, Mr. W. Culverwell, Thorpe Perrow, Bedale, about 1880, carried out the same cross. Mr. Culverwell tells me that only one plant resulted from his first efforts, and that it "flowered the second year, but never fruited." He crossed again, using the 'Whitesmith' Gooseberry as the pollen parent, and eight plants were obtained. The earliest reference to the plants is the raiser's letter to the *Gardeners' Chronicle*, vol. xix. n.s. 1883, p. 635. Referring to the example sent with the communication, presumably the unique plant of the first cross referred to above, the observation is made that it flowered profusely but did not set fruit. There were no spines; and while the wood was like that of the Black Currant (the seed parent), the plant had not the smell of the Currant. Mention is also made of the eight plants "from a recent cross," two of which had the smell of the Black Currant. These were at that period, however, too young to show flower.

In Dr. J. M. Macfarlane's paper on the "Minute Structure of Plant Hybrids," read May, June, 1891, and published in *Trans. Roy. Soc. Edin.*, vol. xxxvii., one of Mr. Culverwell's plants receives special attention. The author found that differences "in leaf form, time of defoliation and habit" existed in the seedlings; and he selected one for detailed examination, which appeared to be "most nearly intermediate between the parents," and left "others which inclined to the Black Currant" to be dealt with at a future time.

In August 1892 Mr. Culverwell had the satisfaction of finding fruit for the first time. He announced this important event in the *Gardeners' Chronicle*, vol. xii. 3rd ser. 1892, p. 161, and in the same volume (pp. 271, 277) a figure and a description of the fruit are given. Mention is made of the chief points of comparative importance between the hybrid and its parents, in respect of their habit, the nature of the wood, and the character of the leaf. The fruit is described as "of the size of Black Currants, but in colour like a red Gooseberry, beset with fine hairs, and destitute of seeds. The flavour partook of that of the Gooseberry mixed with that of the Black Currant."

As far as I can gather, the specimen referred to is the only one of the set which has fruited, and it is no doubt the same as that described by

Dr. Macfarlane (without fruit), as the most distinctly intermediate. Mr. Culverwell, in *Gardeners' Chronicle*, vol. xii. p. 346, mentions that this plant possesses "not a particle of scent like the Black Currant," and, further, that "the Gooseberry caterpillar is particularly fond of the hybrid, whereas it will not touch the Black Currant."

Five years ago I succeeded at St. Andrews in repeating the same cross, and my stock consists of three indubitable hybrids. Besides these, however, there appeared a number of plants of pure Black Currant; the latter vary among themselves a little, but are no doubt the result of accidental self-pollination. Such an accident is not altogether easy to avoid in experimenting with the Black Currant. I understand that Mr. Burnett weeded out some plants from his crossed stock, because he regarded them as Black Currant seedlings; and the reference made by Mr.

FIG. 78.—FLOWERING-SHOOT OF R. NIGRUM × R. GROSSULARIA, B (nat. size).

Culverwell (above quoted) to two of his seedlings possessing the Black Currant odour seems to point to a similar accident having befallen him in his experiments, although the incident may now be forgotten.

I was unfortunately unable to take note of the names of the varieties I operated with, or the number of fruits set and seeds sown. The three hybrids (A, B, C) proclaim their authenticity unmistakably in the form of their foliage. Two of them (A, B) flowered for the first time last year (1898); the third (C), which has not flowered yet, is not so robust. With different treatment they might have been brought into flower at an earlier age. The stronger two are not quite similar, the one (A) being of taller habit, rather less floriferous, and with flowers rather larger than the other (B) (fig. 78). All three bear a marked general resemblance to Mr. Culverwell's best known form, but are distinguishable from it

in minor points in leaf and flower. Spines are entirely absent in Mr. Burnett's, Mr. Culverwell's, and my own hybrids.

In comparing the hybrids with their parents it has to be kept in mind that, while there is but little structural difference in varieties of Black Currant, much more exists in varieties of Gooseberry, both in flower and foliage. As already stated I cannot now identify the Gooseberry parent of my hybrids, and I am accordingly unable to make definite statements as to the origin of peculiarities exhibited by them.

While the size and the shade of colour of Gooseberry leaves may vary, the form is almost always the same, a marked characteristic being the non-cordate base. In Mr. Culverwell's plant there is a closer approach in leaf form to the Gooseberry than obtains in my plants, the leaves of the latter (A, fig. 81; C, fig. 82) being more distinctly cordate. No Black

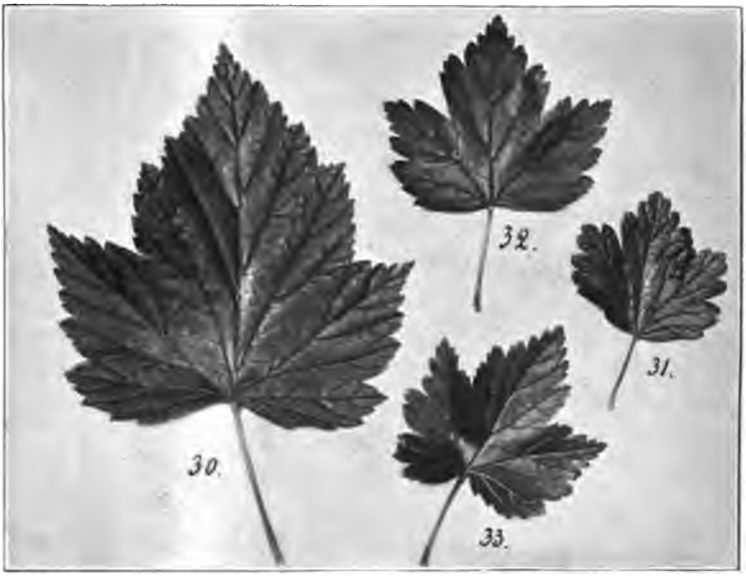


FIG. 79 (30).—BLACK CURRANT. FIG. 80 (31).—GOOSEBERRY. FIG. 81 (32).—HYBRID, A. FIG. 82 (33).—HYBRID, C.

LEAVES (nat. size).

Currant odour is emitted when the leaves of my hybrids are bruised, and, as in Mr. Culverwell's case, the Gooseberry caterpillar finds them specially palatable.

A few irregularly scattered, colourless, stalked glands are found on the under side of the leaves of my plants and Mr. Culverwell's also. The head is multicellular, much flattened, ·1 mm. in diameter, and the stalk is very short, and is not more than ·03 mm. in diameter. It seems certain that these glands disappear for the most part as the leaf attains maturity. No quite sessile ones, reproducing the form of those in the Black Currant, were met with. I am accordingly led to dissent from Dr. Macfarlane's opinion (*loc. cit.* p. 274) that any reproduction of the sessile glands of *R. nigrum* is found to occur in the hybrid.

The number of flowers in the inflorescence of the Black Currant may occasionally be as high as thirteen, but a very common number is either seven or eight. In the Gooseberry two is the maximum, and very often there is only one. In my hybrids the inflorescence most commonly bears three flowers pretty close together. The length of the inflorescence is 1 to $1\frac{1}{4}$ in., or at most $1\frac{1}{2}$ in. Very often there are four flowers, three of which are grouped together terminally, and the fourth borne on a rather long pedicel which arises from the very base of the inflorescence. This basal flower is often later in opening than one or more of the others. Occasionally there are two or even three flowers borne on a common rachis, in place of one basal flower. The greatest number of flowers hitherto observed on any spur is thus five or six; but the usual number, as already mentioned, is either three or four. The peculiar position of the basal flower and the retardation of its opening are features frequently exemplified in the Black Currant and inherited from it.

The hybrids are decidedly later than the Gooseberries in commencing to flower, and are in full blossom when the latter have almost passed out of flower and are bearing fruit of considerable size. On the other hand, while one or two of the hybrid flowers may be open before any of the Black Currant ones, they may be regarded as contemporaneous with them.

In the Black Currant flower the bright yellow scent-secreting glands are very characteristic structures. They number from fifty to eighty, or even more, and are scattered irregularly over the surface of the ovary and the calycine cup as well. They are quite sessile (fig. 83), and very often placed at the bottom of a shallow depression. Their diameter is very uniform, being ·15 mm. to ·17 mm. A number of smaller ones, however, may be found. Their structure has been described by several botanists. The gland is multicellular, and the cuticle is commonly found raised by the yellow secretion which accumulates beneath it.

In the Gooseberry we find greater diversity in respect of gland-bearing in the flower. In some varieties the ovary is tomentose and thickly studded with long-stalked red glands (fig. 85). In others, the numerous glands are colourless, or almost colourless. Further, varieties are met with in which the ovary is densely clothed with soft white hairs, amongst which occur a few irregularly scattered long-stalked red glands; while others, still tomentose, are absolutely destitute of glands. Finally, glands may be quite absent, and the ovary be almost or altogether destitute of hairs as well. When hairs are present they also clothe, but less densely, the calycine cup. Glands, however, never occur on the cup. The glands may have a diameter of ·1 mm., and the stalks attain the length of 1·2 mm. The red colour often extends some distance down the stalk.

In the 'Whitesmith' Gooseberry, the pollen parent of Mr. Culverwell's hybrids, the ovary (in the specimens examined by me) was tomentose, with a few red glands borne on long stalks. They numbered from four or five to twenty-four, at most, in the plant studied. The stalk was usually 1 mm. in length, and the red colour of the glands extended a little distance downwards. The average diameter of the glands was ·14 mm., the largest being ·16 mm. The stigma stood only a little above the anthers, and the pollen was very good.

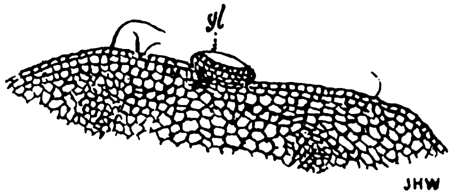


FIG. 83.—PORTION OF OVARIAN WALL OF BLACK CURRANT, IN TRANSVERSE SECTION (magnified).

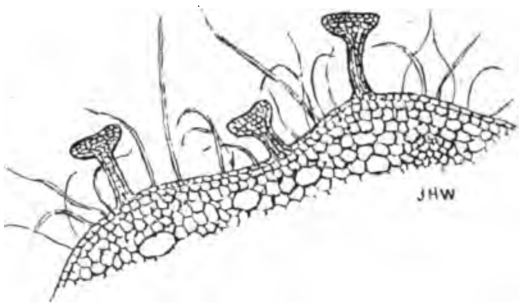


FIG. 84.—PORTION OF OVARIAN WALL OF HYBRID (magnified).

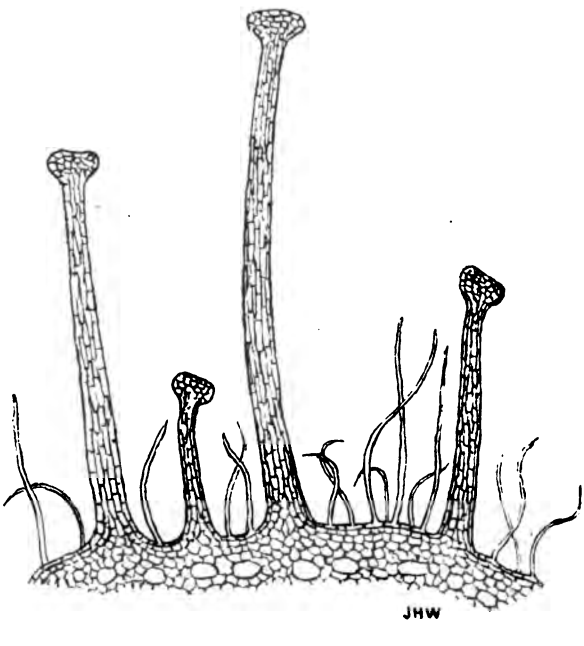


FIG. 85.—PORTION OF OVARIAN WALL OF GOOSEBERRY (magnified).

It is interesting to find that in Mr. Culverwell's hybrid short-stalked glands occur on the ovary and on the lower part of the calycine cup also. They are never quite sessile, and are large enough to be easily seen by the aid of a hand lens. Their stalks are relatively delicate, and vary in length from ·03 mm. to ·06 mm. The diameter of the gland is commonly from ·1 mm. to ·12 mm. Very often the glands are bright red, but commonly enough they are colourless. At least as many as twenty-four red glands may be found in one flower, besides numerous colourless ones. All gradational stages, from the claret-coloured to the colourless, occur. Sometimes the coloured ones are found on one side of the ovary, and the colourless ones on the other. I have not noticed any sessile yellow glands, and I am therefore unable to corroborate Dr. Macfarlane's statement (*loc. cit.* p. 231) that "four types" of "hairs," including sessile glands, are present on the ovarian surface of this hybrid.

The bright-red coloured glands, above described, may with considerable assurance be regarded as identical in structure and function with those in the Gooseberry, and there seems no good reason to suppose that the absence of colour in the others constitutes a material difference.

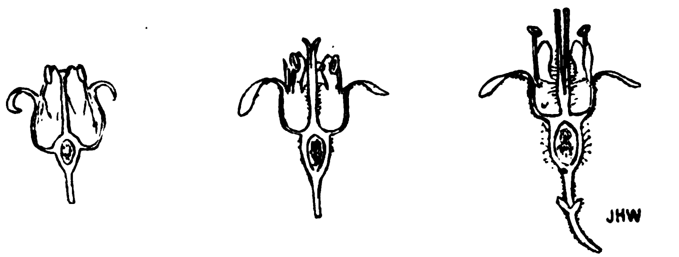


FIG. 86.—BLACK CURRANT. FIG. 87.—HYBRID. FIG. 88.—GOOSEBERRY.
FLOWERS IN SECTION (× 2).

Stalked glands of the same size as those in Mr. Culverwell's hybrid, and occupying a similar position, occur in the flowers of my two hybrids (fig. 84). The diameter of the glands is ·1 mm. to ·13 mm., and the length of stalk ·03 mm. to ·13 mm. I have, however, never seen any of them red-coloured; and I am accordingly inclined to believe that a variety of Gooseberry with little or no colour in the glands may have been the parent of my plants.

If the bisected flowers of my hybrids and their parents be compared (figs. 86, 87, 88), many features showing a blending of the parental characters will be observable. The ovary is nearly intermediate in size. The style arises from an almost flat surface in the Gooseberry, and from a greatly arched surface in the Black Currant. It is raised on a slight elevation in the hybrids.

The style in the Black Currant (fig. 86) is solid and glabrous, and the stigma inconspicuously bifid. In the Gooseberry (fig. 88) the style is cleft almost to the base, and is clothed with hairs which radiate horizontally, the longest being at the level of the throat of the flower. In the hybrids (fig. 87) the style is cleft nearly midway, and bears hairs which are much fewer in number and shorter than those of the corresponding organ of the Gooseberry.

The interior of the cup in the Black Currant is destitute of hairs; in the Gooseberry hairs similar to those on the style project inwards from the base of the petals and filaments, and are long enough to meet the hairs of the style. In the hybrids only a few short hairs occur in this position, or they may be altogether absent.

There is much red coloration in the upper side of the sepals in the hybrids, the colour being developed chiefly at the base and margins. Very often short fine hairs are present on the upper side of the distal half of the sepals. The petals are white, and are less distinctly spathulate than in the Gooseberry.

The filaments are markedly adherent in the Black Currant, non-adherent in the Gooseberry, and slightly adherent in the hybrids. The anthers of the hybrids are of good size, but the pollen is deficient in quantity and highly abnormal. In a microscopic examination of it, one scarcely finds a single grain with any appearance of soundness, a condition of affairs met with also in Mr. Culverwell's hybrid.

My plants are visited freely by humble and hive bees, and would inevitably be fertilised if the pollen were good. Perforation of the side of the flower of Mr. Culverwell's hybrid by bees is a not uncommon occurrence, and the aperture thus formed may sometimes be so enlarged by repeated visits as to become confluent with the mouth of the flower. I have not noticed any of the flowers of my hybrids similarly pierced.

In one of my hybrids (B, fig. 87), as in Mr. Culverwell's best known plant, the stigma protrudes so far beyond the stamens as ordinarily to escape self-pollination; but in the other (A) a good many of the flowers have styles so shortened that the apices of the anthers are in very close proximity to the stigma, and self-pollination might take place, especially when the flowers have faded a little.

Mr. Culverwell informs me that all he does to assist in the fertilisation of his plants is to shake the bushes when the atmosphere is a little damp. It is very likely that a drop of water might suffice to convey the pollen to the stigma hanging below the anthers, and shaking, or the action of the wind, might also help; but the difficulty encountered after all is the probability of the pollen being impotent. On the other hand, it is highly probable that many of the flowers are pollinated by bees which have come direct either from Gooseberry or Black Currant bushes. My plants grow beside Black Currants, and I have observed bees passing from the latter to the former, and *vice versa*. If Gooseberry bushes had been near by, a similar transference of pollen between them and the hybrids would certainly have taken place.

Mr. Culverwell kindly sent me some shoots in fruit last year. I understand that as many as four fruits may be carried by a single spur. Two is a common number. The fruits are slightly bigger than a large Black Currant, often flattened considerably, and in colour, as already noted, resembling a dark red Gooseberry. The flavour is that of the Gooseberry, decidedly and very palatably mingled with that of the Black Currant. It is interesting to find that the somewhat thin and rather tough skin, if pressed on white paper, leaves a pink stain, whereas the Black Currant leaves a purple stain, and the Gooseberry none at all.

All the fruits examined by me, numbering twelve or more, like those

previously examined by others, were absolutely seedless, a few minute scales at best being present in place of seeds.

During the present summer (1899) I endeavoured to fertilise the flowers of my hybrids, using a variety of pollen as follows: 44 flowers received pollen from the Gooseberry (7 different kinds); 19 from the Black Currant, and 16 from *Ribes divaricatum.* Further, in 7 cases, pollen (such as it was) was taken from other flowers of the same hybrid, and in five cases it was taken from one hybrid to the other. As an outcome of the 72 attempts enumerated, one berry has been secured, and it has been due to the application of the pollen of *R. divaricatum.*

This fruit ripened and fell, when lightly shaken, fifteen weeks after fertilisation. It was $\frac{3}{10}$ in. in length, of oval outline, but asymmetrical; the remains of the perianth forming an appendage $\frac{1}{8}$ in. long; the skin red like a red Gooseberry, sparsely clothed with very fine white hairs, amongst which occurred 20 to 30 stalked glands. The latter could be readily seen with a lens magnifying a few diameters, and were just visible to the naked eye when placed against a suitable background. The pulp was palatable. No seeds were present.

This remarkable result naturally leads to the suggestion that as a practical matter certain species or varieties of *Ribes* might with advantage be planted in the vicinity of the hybrids, so as to help in the setting of fruit.

It should be remembered that my two flower-bearing plants have not been propagated. It is not improbable that cuttings might have a stronger tendency to fruit. Budding on other kinds of *Ribes*, or even transplantation into other soil, might have the desired effect.

An examination of the ovules of my hybrids, and of Mr. Culverwell's also, by hand sections, did not disclose any abnormal features; but further investigation, including the styles as well as the ovaries, is needed before a satisfactory explanation of the partial or complete sterility can be attempted.

It is evident from information most obligingly supplied me by Mr. Burnett, and from examination of material sent, that his hybrids bear a very close general resemblance to mine in all respects. I found, however, that the younger leaves studied bear a far greater number of minute, colourless, very short-stalked glands than do any of the plants above described. They are dotted over the whole under side of the leaf blade, to all appearance almost, if not quite, as thickly as the sessile yellow glands are in the Black Currant. They appear as minute white dots under the hand lens, and are rather less than half the average diameter of the Black Currant glands.

In the flowers studied the pedicel, ovary, and calycine cup are virtually glabrous, only a very few minute hairs being present. Minute almost sessile colourless glands like those in the hybrids already described, and ·08 mm. in diameter, occur on the ovary. They are so few as to be easily overlooked altogether. One was observed to have a very little red coloration. The petals are wider than in my plants, and overlap considerably. The style rises from a distinctly arched base. The hairs on the style and in the throat of the flower resemble those in my hybrids, and the stigma projects some distance, as in one of my plants (B). The

anthers having been lost in transit, no opportunity of studying the pollen of Mr. Burnett's plant was afforded.

BEGONIAS (TUBEROUS VARIETIES) × B. COCCINEA.

The so-called Tuberous Begonias, as is well known, have a rather complex pedigree. In spite of this, they are wonderfully fertile, large capsules of good seed being very readily obtained when certain strains are desired. It did not, however, seem at all likely that the pollen of a species so essentially different from the Tuberous Begonias as *B. coccinea* is would serve to fertilise their flowers, and yet it has proved potent to a very marked degree. Experiments resulted in fine capsules being formed, and the seed sown produced very numerous seedlings of most vigorous character. The very first leaves of the seedlings displayed a feature of much interest, the upper surface being dotted with silvery spots. As growth proceeded, there was no disappearance of this character, all the leaves of all the specimens during the vegetative period of the first season being more or less distinctly spotted. There was very considerable diversity in respect of the number and size of the spots, these being in some cases of fair size and relatively few in number, in others minute and in great numbers. The under surface was commonly red, often a fine deep red, and always quite destitute of spots. The shape of the leaves betokened the influence of both parents.

Singularly striking variation was exhibited in the mode of growth of the stems and branches, affording a rather bewildering field of observation. Examples, for instance, occurred having a single stem which grew straight up to the length of 12 to 14 in., and developed a spherical swelling at its base; others had single but branching stems; others again had one or more shorter or longer, branched or unbranched, stems springing from a semi-tuberous base (fig. 89) and so forth.

At the resting period further study disclosed very many grades between the ideal "tuberous" and "non-tuberous" conditions, neither extreme, however, being represented. It was of unusual interest to note the results of the ripening process, some or many of the joints, or even entire branches, falling off naturally, and leaving the plants ultimately with a broken and abbreviated appearance. (Fig. 90.)

In spring the bursting of the more vigorous buds here and there on the branches, stems, or swollen bases served further to emphasise the peculiar conditions which the ebbing of the vitality, so to speak, had occasioned in autumn. (Fig. 91.)

The somewhat nondescript perennating structures were rather difficult to winter successfully, and it is probable that a certain amount of drying-off given to these may have proved severe, for the plants thus treated have not grown so freely as might have been expected, nor have any of them flowered yet.

A new series with similar parentage, sown this season, is showing a striking difference from the above, inasmuch as although the young leaves were similarly spotted, the spots have tended to disappear in the older leaves. Up to the present the resemblance to the pollen parent,

FIG. 89.—RED TUBEROUS BEGONIA × B. COCCINEA—THE TOP LEAVES CUT AWAY
nat. size).

B. coccinea, is greater in the new series than in that above described.

Seeing that no spots occur in the adult leaves of the parents, it was at first puzzling to account for their presence in the hybrids. The solution of the problem was, of course, to be looked for by studying the young leaves of the parents, arising either from the seed or the bud, or both. I am not aware that the seedlings of Tuberous Begonias ever exhibit the peculiarity in question, and I have not yet had opportunity of observing seedlings of *B. coccinea*. In the latter, as grown from cuttings, one seldom sees any spots, but now and then a young shoot is found bearing quite distinctly spotted leaves. In the meantime, therefore, one

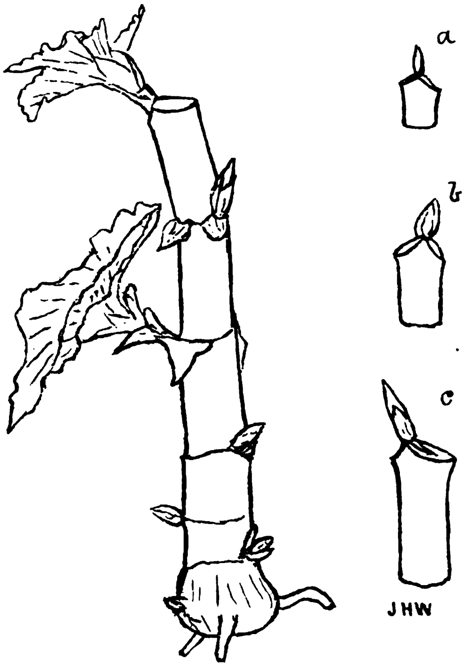


FIG. 90.—RED TUBEROUS BEGONIA × B. COCCINEA; *a*, *b*, *c* FALLEN JOINTS (nat. size).

can only surmise that a character usually latent in one of the parents finds scope for fuller expression in the hybrid offspring.

In the second series, the general habit of the plants and the form of the leaves clearly point to *B. coccinea* being rather more potent than before; and the partial disappearance of the spots at an early stage suggests that, while in the hybrids of the previous year an early phase of vegetative life of the male parent was impressed on the offspring, in the newer hybrids a more mature condition is represented.

On the other hand, it must not be forgotten that the female parents come of a very variable stock. Those used in the second set of experiments were a newer and somewhat finer class of Tuberous Begonias.

A singular corroboration of the view that it is to the action of the pollen parent, *B. coccinea*, that the spots are due, has been afforded by seedlings of *B. hydrocotylifolia* × *B. coccinea*, raised during the present

season (1899). In these the leaves, some of which are 3¾ in. long at the time of writing, are all beautifully marked with silvery spots, and, but for their blunter apices, would be indistinguishable from the first series of hybrids having Tuberous Begonias as seed parents.

NOTE.—At the Conference illustrations were shown and brief notes given of other hybrids than the above described, viz.—

(1) Hybrid Albucas, involving in a variety of ways the following

FIG. 91.—RED TUBEROUS BEGONIA × B. COCCINEA (nat. size).

species: *A. corymbosa*, *A. prolifera*, *A. caudata*, *A. Nelsoni*, *A. fastigiata*, *A. trichophylla*, and *A. minor*. It was mentioned that as many as five of these were united in the parentage of certain of the crosses.

(2) *Begonia semperflorens* × *B. fuchsioides*.

(3) *Abutilon Darwinii*, var. (?) × *A. megapotamicum variegatum*.

(4) *Centaurea ragusina candidissima* × *C. Scabiosa*.

It is intended to incorporate the notes and figures of Albucas in a

work at present in course of preparation. The description of the other hybrids named may well be postponed.

It remains to be mentioned that the whole of the experiments detailed in the present paper have been carried out at Greenside Nursery, St. Andrews, under most favourable circumstances.

Discussion.

Mr. Webber: I should like to say, in regard to the parentage of the two Begonias which the doctor used in order to secure the spotted hybrids, that this seems to me to be exceedingly interesting, as it is a new feature. I should like to know if it is at all probable that the parents were mixed in any way, and that this may be a reversion to some previous parent.

Dr. Wilson: The Tuberous Begonias, as everybody knows, are complex hybrids, so you might look for reversion. I am sorry I do not know enough about the parent species to say if any of them have spotted leaves; but it should be borne in mind that the leaves of *B. coccinea* are certainly spotted sometimes. If anybody has grown it from seed he may know whether it is spotted in its early stages.

Fig. 92.—Phalænopsis Ludde-violacea. (*Journal of Horticulture.*)
(P. Luddemanniana × P. violacea.)

HYBRIDISATION VIEWED FROM THE STANDPOINT OF SYSTEMATIC BOTANY.

By R. Allen Rolfe, A.L.S., Kew.

"In the year 1819," remarks Herbert, "having for some years previous paid attention to the production of hybrid vegetables, . . . I was induced . . . to address some detailed observations on the subject to the Horticultural Society, which were published in the 'Transactions' of that body (iv. pp. 15–50). . . . Soon after the publication of that communication . . . I was accosted by more than one botanist in the words, 'I do not thank you for your mules,' and other expressions of like import, under an impression that the intermixture of species, which had been commenced and was earnestly recommended to cultivators, would confuse the labours of botanists, and force them to work their way through a wilderness of uncertainty; whereas it was evident to myself that it would, on the contrary, afford a test whereby the accuracy of their distinctions might be more satisfactorily investigated, many of the errors of their systems eradicated, and its details established upon a more solid foundation, and less upon the judgment and caprice of individuals" ("Amaryllid.," pp. 335, 336). A period of upwards of sixty years has since elapsed, during which period the practice of hybridisation has progressed by leaps and bounds, and with the greatest benefit to horticulture, though the gain to systematic botany is not yet so apparent. The fact, certainly, that hybrids occur in a wild state is now more or less admitted, and many such plants have been recognised and described; indeed, Herbert himself quotes a list of no fewer than nineteen genera in which spontaneous hybrids had already been recorded—which fact doubtless influenced his remarks—but even at the present day there is a good deal of scepticism among systematic botanists on the subject, as may be seen from a recent controversy respecting the genus *Epilobium* (the Willow-herbs).

As long ago as 1831 Lasch recorded the occurrence of supposed natural hybrids in this genus, and enumerated several which he believed he had recognised ("Linnæa," vi. pp. 493–497); while others were subsequently added, until in 1884, when Haussknecht monographed the genus, he enumerated a list of over sixty European ones. After perusing this work the Rev. E. S. Marshall collected a number of remarkable British forms, and sent them, with others gathered by friends, to Prof. Haussknecht for determination. This was repeated for three successive years, with the result that twenty-seven natural hybrids were recognised, two of them being new to science ("Journ. of Bot.," 1889, pp. 143–147; 1890, pp. 2–10; 1891, pp. 6–9).

The correctness of Haussknecht's views was soon challenged. The well-known botanist Mr. C. B. Clarke, F.R.S., wrote: "Haussknecht's . . . hybrids are altogether beyond me" (*l.c.*, 1891, p. 228); to which Mr. Marshall replied that the question of hybridity was not to be "dis-

missed offhand, as though it could be safely ignored. . . . I can affirm that anyone with a fairly quick eye will soon be able to settle the question for himself, as regards this particular genus, beyond all reasonable doubt. . . . I cannot see why it should be inconceivable for insects to do unconsciously what all are agreed that florists do consciously and more clumsily" (*l.c.*, 1891, p. 298). Mr. Clarke retorted: "I have not . . . dismissed hybrids offhand; where I have had time to come to close quarters with them, however, they have invariably broken down." He then described how they "arise" (which is too long to repeat), concluding: "The makers of hybrids often go no further than the diagnostic characters of systematists; their hybrids are not hybrids between any two plants that ever lived, either species, crosses, or individuals, but hybrids between two of the hybrid-monger's own diagnoses" (*l.c.*, 1892, p. 80). This Mr. Marshall not unnaturally described as "caricature pure and simple" (*l.c.*, 1892, p. 107).

Mr. N. E. Brown, in the Supplement to Syme's "English Botany," published in 1892, also remarked of these twenty-seven supposed natural hybrids: "Supposed to be natural hybrids, and are considered as being intermediate in character between their supposed parents. Possibly some of them may be hybrids, but those . . . that I have seen, named by Prof. Haussknecht, Rev. E. S. Marshall, and others, appear to me at the utmost but trifling variations of one or other of their supposed parents, the differences between the supposed hybrid and the species it most resembles being no greater and sometimes not as great as may often be found between individuals in a bed of seedlings from one plant, and I see no use in inserting in our floras descriptions of such plants" (*l.c.*, p. 175).

One of these very plants had long previously been raised artificially, though none of the authors mentioned seems to have been aware of the fact. Sir James E. Smith, in 1800, had remarked concerning *Epilobium roseum*: "Is it possible it may have originated from seeds of the latter [*E. tetragonum*] impregnated by the pollen of *E. montanum*?" ("Engl. Bot.," x., t. 693.) In order to test this suggestion Dr. Bell-Salter, about the year 1842, fertilised *E. tetragonum* with pollen of *E. montanum*; seeds were readily produced, and hybrids obtained, which were described as intermediate between the parents, but different from *E. roseum*. He then reversed the cross, but the progeny proved indistinguishable. These hybrids were raised true from seed for four successive years, and up to the date of his writing (1852) plants continued to make their appearance ("Phytologist," iv. p. 739).

The result of this experiment was doubly interesting, for not only is *E. roseum* now recognised as a common and widely diffused species, but the hybrid has also long been known in a wild state. According to Haussknecht it was described as long ago as 1831 by Lasch under the name of *E. subtetragono-montanum* ("Linnæa," vi. p. 495), and by Celakovsky, in 1881, as *E. Freynii* ("Prodr. Fl. Bohem.," p. 881). It is found in several different localities where its parents grow intermixed.

These facts are given to show the diverse views which still prevail, and it may seem strange to hybridists that such an amount of scepticism, and even prejudice, should still exist. The reason, however, is not difficult to

explain. Botanists necessarily have to base their system of classification upon the similarities and differences which exist in the plants they investigate, and can hardly be expected to view the obliteration of their most reliable marks of distinction, which the work of the hybridist entails, with equanimity. And it is notorious that in certain groups the marks of distinction between species, and even genera, have been broken down by this means, with the result that hybrids, for the most part, have been regarded unsympathetically by botanists or ignored. Some, it is true, have contended that hybridisation is also carried on in nature, but their views have met with a good deal of opposition, as we have just seen.

On the other hand, hybridists have done very little to remove this prejudice. They have, for the most part, devoted themselves to raising new and improved races of garden plants, without much regard for the botanical side of the question, which perhaps helps to explain the undoubted want of sympathy between the two classes of workers, and which I hope this Conference will at least do something towards removing.

It is a fact beyond dispute that certain plants which occur in a wild state, and have been described as species, have also been produced artificially by crossing together two other distinct kinds; and that such plants are natural hybrids can scarcely be denied by the greatest sceptic. The number, I am convinced, might be rapidly increased if hybridists would make the necessary experiments. It is perhaps too much to expect them to demonstrate the origin of our much-disputed Willow-herbs, but there are groups which they have already in hand in which certain crosses might be made. Among Roses, for example, Crépin has described numerous wild hybrids ("Bull. Soc. Roy. Belg.," xxxiii. pp. 1–149), while in gardens numerous artificial crosses have been made; yet Mr. Baker tells me that so far as he knows not one of these artificial crosses has demonstrated the origin of any wild hybrid, the reason of course being that the right species have not yet been crossed together. Botanists themselves might do more to demonstrate the truth of some of their speculations on the subject.

A good many experiments have already been made, and with most promising results. Among the earliest undertaken with this express object were those by Herbert in the genus *Narcissus*. About the year 1835 a collection of the known Narcissi was made at Spofforth for the completion of an arrangement of the Amaryllidaceæ; and with a desire of seeing the fruit of some of Haworth's genera, application was made for seed to various cultivators, when it was found that no one had ever known a seed to be produced. The suspicion then arose that they might be hybrids, and accordingly certain experiments were made. *N. incomparibilis* was known to be wild in France, and it had been a question among collectors whether it was generated accidentally between the common Daffodil and *N. poeticus*, which Herbert remarked might be expected to produce such a hybrid. He accordingly crossed a Daffodil with pollen of *N. poeticus*, and when the seedlings flowered they proved identical with *N. incomparibilis*, as may be seen by consulting the coloured figure ("Bot. Reg.," xxix., t. 38, fig. 5). In a similar way Herbert thought that if the Daffodil would cross with the Jonquil, *N. odorus* might

be produced, and this experiment was also successfully made, and the opinion verified. "Plants," he remarked, "have been raised both by myself and by Mr. Trevor Alcock, near Caermarthen, and, having flowered, have shown that the Linnean *N. odorus*, the genus *Philogyne* in all its variations, is cross-bred between Ajax and Jonquil" ("Journ. Hort. Soc.," ii. p. 24). The cross between the Daffodil and *N. poeticus* was repeated more than once, and also reversed, and numerous varieties produced, which Herbert considered "sufficient to establish the point that the several varieties, single and double," of *N. incomparibilis* were hybrids between the two species (*l.c.*, p. 22).

The experiment was confirmed by Leeds, who raised *N. incomparibilis expansus* from *N. pseudonarcissus, var. major*, crossed with *poeticus* (Moore and Ayres, "Gard. Mag. Bot.," iii. p. 289, fig. 2), and also *N. Leedsii* from precisely the same parentage (*l.c.*, p. 169, fig. 2). Commenting on this, Mr. Leeds remarks: "It is quite clear . . . that *incomparibilis* is no species. . . . I think . . . the number of species is very small." Yet in 1888 we find Mr. Baker enumerating *N. incomparibilis* as a species, and *N. Leedsii* as a hybrid ("Handb. Amaryll.," pp. 5, 14). Grenier and Godron also treat *N. incomparibilis* as a species, mainly because it has been found growing by itself, but a scarcely distinguishable plant found growing with its two parents they admit as a hybrid, under the name of *N. pseudo-narcisso-poeticus* ("Fl. de France," iii. pp. 254, 255). It is known, however, that both *incomparibilis* and *odorus* become naturalised in suitable localities, and their existence in isolated spots in no way disproves their hybrid origin.

Herbert believed that other so-called species were really hybrids, adding, "I have more than once had seed from *N. poeticus* by the Jonquil, which would indubitably have produced *N. gracilis*, but the seedlings have been neglected and the labels mislaid" ("Journ. Hort. Soc.," ii. p. 26). He also raised *N. Spofforthiæ* by crossing *N. incomparibilis* with the pollen of *N. poeticus*, and expressed himself as being as confident of the origin of some others as if he had "obtained them from seed," adding, "And I have not troubled myself to make the like" (*l.c.*, p. 22).

Messrs. Damman, of Naples, it may be observed, have now demonstrated the hybrid origin and parentage of *N. gracilis*, Sabine, and proved the correctness of Herbert's opinion, for seedlings between the Jonquil and *N. Tazetta* raised by them certainly belong to *N. gracilis*. They, however, used the Jonquil as the seed parent. *N. tenuior*, Lois, which Mr. Baker also classes as a distinct species, is a form of the same hybrid.

The Rev. G. H. Engleheart has proved the hybrid origin of *N. biflorus*, Curt., by crossing *N. poeticus* with the pollen of *N. Tazetta* ("Journ. Roy. Hort. Soc.," xii. p. 317, also lii.), and subsequently from the reverse cross (*l.c.*, xix. p. 12), some of the seedlings being identical with wild forms, thus confirming what has long been suspected. Grenier and Godron, it may be remarked, enumerate *N. biflorus* as a species ("Fl. de France," iii. p. 256), but on the next page they give *N. Tazetto-poeticus*, though they were unable to point out any tangible character by which the two could be distinguished.

The pretty little *N. pulchellus*, Salisb., has also been reconstructed by the Rev. G. H. Engleheart by a cross effected between *N. triandrus*

and the Jonquil, the seedlings proving absolutely identical with the wild plant. Mr. Baker classes this hybrid as a form of *N. triandrus*.

Perhaps the first direct experiment of this kind was made by Linnæus, who suspected the hybrid origin of a certain *Tragopogon* in the garden at Upsala, where *T. pratensis* and *T. porrifolius* were cultivated. Accordingly he fertilised flowers of the former with pollen of the latter, and obtained seedlings, which flowered in the summer of 1759, and proved identical, receiving the name *T. hybridum* ("Amoen. Acad.," x. p. 126). This hybrid has since been found in a wild state with its two parents.

A hybrid *Verbascum* was also produced in the garden at Upsala in 1761, from seeds of *V. lychnitis* impregnated with the pollen of *V. Thapsus*; which Withering states also grows wild in Kent ("Brit. Pl.," ed. 3, ii. p. 249). Mr. Griffith, of Denbighshire, also raised it artificially from the same cross, and sent specimens to Sir J. E. Smith ("Sm. Engl. Fl.," i. p. 310). Kölreuter also raised it, both from the same and from the reversed cross. As a wild plant it is widely diffused in Central Europe.

Another hybrid *Verbascum* was also recorded by Withering (*l.c.*, p. 248), whose history is thus given. In the spring of 1789 a Mr. Robson planted a root of *V. nigrum* near one of *V. Thapsus* in his garden, when both flowered well, and the latter was allowed to stand and shed its seeds. Next spring several plants appeared which were different from either species, but partook of the characters of both, and for five successive seasons they flowered, but produced no perfect seed. Though rightly called a hybrid, it was recorded under its Linnean name of *V. Thapsus var. Thapso-nigrum*, which name itself suggests that its real origin was pretty shrewdly guessed. Kölreuter also raised it from the same and from the reversed cross. It is found wild in various localities in Europe, and has various names.

Various other wild species have been crossed together artificially, and the resulting hybrids have proved identical with wild plants, which in many cases have been originally described as species, and sometimes under various names. According to Focke, no fewer than twenty-three distinct combinations have been made artificially which have yielded hybrids identical with wild ones, and one of these, namely, *V. blattaria* × *phœniceum*, has also appeared spontaneously in gardens where the two species have been grown. One other has been so far proved that spontaneous hybrids, agreeing with wild ones, have appeared where *V. phlomoides* and *V. speciosum* have grown side by side, the pollen having evidently been transferred by insects, as occurs in nature. In at least six of the above cases the parentage was also reversed with the same result.

Digitalis supplies some wild hybrids whose origin has been artificially demonstrated. For example *D. purpurascens*, Roth, has been reconstructed by crossing and recrossing *D. lutea* and *D. purpurea*; and *D. media*, Roth, in the same way from *D. purpurea* and *D. ambigua* (*grandiflora*). The former hybrid is evidently raised with the greatest facility, for it has appeared in several gardens where the two parent species are grown. *D. ambigua* has also been crossed with *D. purpurea* and with *D. lanata*, in each case yielding hybrids which also occur wild.

The hybrid origin of *Geum intermedium* has long been known. Dr. Bell-Salter has recorded how, acting on a suggestion which had been thrown out that it was a hybrid, he crossed *G. rivale* with pollen of *G. urbanum*, and the resulting seedlings proved exactly identical with the wild plant. It also proved fertile, and reproduced itself true from seed ("Phytologist," iv. p. 739). Gärtner also raised it both from the same and the reverse cross, and it is known to occur spontaneously in gardens where the two species are cultivated together. *Geum coccineum* ♀ and *G. rivale* ♂ were also crossed by Gärtner, and yielded a hybrid which has been found in the Rhodope mountains by Janka.

The willows are now known to hybridise with the greatest facility in a wild state, though the early salicologists were mostly unwilling to recognise the fact. By degrees, however, the probability of the phenomenon was admitted, and Wichura demonstrated the truth of these suppositions by raising artificially forms identical with those which had long been known in a wild state. The Rev. E. F. Linton has also raised several hybrids in his garden at Bournemouth, and has kindly supplied me with a few facts for the present paper. Wichura appears to have raised artificially eight hybrids which also occur wild, to which Linton has added at least six others, a few of which may now be considered. *Salix rubra* was for many years ranked as a widely diffused species, yet Wichura obtained it artificially by crossing *S. purpurea* with the pollen of *S. viminalis*. Linton also raised it as a seedling from a viminalis catkin, which had evidently been pollinated with *S. purpurea*, probably by bees. The others raised by Linton are as follows:—*S. repens* ♀ × *purpurea* ♂ yielded *S. Doniana*, Sm., originally described as a species by Smith. *S. viminalis* ♀ × *repens* ♂ produced several seedlings agreeing well with *S. rosmarinifolia*, L., as figured in Sowerby and Smith's "English Botany," t. 1365 (t. 1363 of ed. 3), which Wimmer considered as representing this cross. *S. viminalis* × *triandra* produced *S. hippophaifolia*, Thuil., which was originally described as a species, but afterwards considered to be a hybrid with this parentage by Wimmer. Wichura records three unsuccessful attempts to raise this hybrid, in 1856, 1857, and 1858, *S. triandra* being used as the seed parent ("Bastardbefr. Pflanzenr.," p. 13). *S. repens* ♀ × *Lapponum* ♂ produced a hybrid agreeing well with wild specimens from Sweden. *S. phylicifolia* ♀ × *herbacea* ♂ yielded a hybrid strongly resembling *S. Moorei*, which is believed to have originated from this cross ("Journ. of Bot.," 1896, p. 470). Finally *S. Lapponum* ♀ × *phylicifolia* ♂ yielded a very variable hybrid, which has since helped to determine the origin of a wild Scotch plant. A few crosses entirely failed—indeed the process is said to be liable to all sorts of miscarriages—and a few others yielded hybrids not yet recognised in Britain, but the results are certainly valuable and suggestive.

Some of these proved hybrids, as we have already seen, were originally described as species, as were also many others whose hybrid origin is now fully recognised. In 1830 Sir J. E. Smith recognised sixty-four British species of *Salix* ("Engl. Fl.," ed. 2, iv. pp. 163–233. "Full thirty years," he observes, "have I laboured at this task [of specific distinction], ten of them under the instructive auspices of my late friend Mr. Crowe, in whose garden every Willow that could be got was cultivated. . . . The plants

were almost daily visited and watched by their possessor, whom no character or variation escaped: seedlings innumerable, springing up all over the ground, were never destroyed till their species were determined, and the immutability of each verified by our joint inspection. This was the more material, to set aside the gratuitous suppositions of the mixture of species, or the production of new or hybrid ones, of which, no more than of any change in established species, I have never met with an instance" (*l.c.*, p. 164). In 1890 Dr. Buchanan White wrote a Monograph of the British Willows ("Journ. Linn. Soc.," xxvii. pp. 333–457), in which he enumerated seventeen species and forty-one hybrids. Many of Smith's so-called "species" are now ranked as varieties, but at least six of them are hybrids, and the number may yet have to be increased, for secondary hybrids have been raised artificially, and on the Continent a few have been recognised in a wild state; and the result of such recrossing of a species with its hybrid offspring might easily be passed over as a variety only unless its origin was known.

An even worse state of confusion exists in the genus *Hieracium*, which seems to be about where *Salix* was in Smith's time. "New species," so called, have recently been described wholesale, both on the Continent and in England, and in some cases the constancy of their characters has been tested under cultivation. But what is their systematic value? Babington recognises thirty-two British species, but Bentham thinks that seven "will probably be found to be the only truly botanical species indigenous to Britain." What, then, are the others? Bentham says the species are some of them very variable, and specimens are frequently found apparently intermediate between some of the commonest ones." The phrase is suggestive of their origin, and I have little doubt that some of the recently described British "new species" are natural hybrids. Indeed, two of three were indicated as hybrids by Hanbury, though a further remark perhaps indicates why others were not so regarded:—"As recent numbers of this Journal show that there are those who refuse to believe in the existence of hybrids, even among . . . [*Salix* and *Epilobium*] I give up as hopeless the task of endeavouring to convince such that they exist among Hieracia" ("Journ. of Bot.," 1892, p. 370). They do exist, nevertheless, doubtless in large numbers, and at all events some have been reconstructed artificially, being certainly identical with the wild types. F. Schultes and G. Mendel raised several artificially, and at least seven of them I have seen in the dried state. Many natural hybrids have been recognised by Continental authors, and I quickly found thirty such plants in the Herbarium at Kew, with their supposed parentage indicated, and in two cases both the wild and artificially raised hybrids are represented. Four artificial crosses between distinct species, which also occur wild, are recorded by Focke, namely *H. auricula* × *pilosella*, *H. prœaltum* × *pilosella*, *H. auricula* × *pratense*, and *H. aurantiacum* × *auricula*, and it appears that the second of these crosses proves the origin of no fewer than eleven so-called "species"—plants which at least have received specific names—and the last as many as four. Surely no more eloquent comment is needed, and we may pass on.

Rubus is another genus which presents that "chaos of undecided forms in the face of which all the efforts of botanical describers miscarry," and

I believe that no further progress is possible without a fuller recognition of the fact that hybridisation, as well as polymorphism, occurs. Natural hybrids certainly occur, and Focke has succeeded in reconstructing two of them artificially, namely, *R. pruinosus*, Arrh., from *R. Idæus* ♀ × *cæsius* ♂; and *R. neglectus*, Peck, from *R. Idæus subsp. strigosus* ♀ × *occidentalis* ♂.

Incredible as it may seem to-day, few botanical questions have been more often or more warmly discussed than the one whether the Cowslip and Primrose are distinct species or only forms of one, the reason being the occurrence of intermediate forms, called Oxlips, which we now know to be hybrids. Linnæus, who certainly had a suspicion of the truth, ranked both the Primrose and Oxlip as varieties of *P. veris* (the Cowslip). Sir J. E. Smith, in 1790, clearly suspected the Oxlip to be a hybrid, remarking, "If not a hybrid production between the other two, it may perhaps with the greatest propriety be reckoned a variety of the Primrose" (Sowerby and Smith, "Engl. Bot.," t. 4). Various experiments were made to ascertain the truth of this hypothesis. Mr. Hewett C. Watson brought into his garden a wild "Claygate Oxlip," planting it near Cowslips and Primroses, so that the flowers might be hybridised by bees—if hybridisation really took place. He carefully marked it, and sowed the seeds, and from them he states that he obtained plants of the Oxlip, Cowslip, and Primrose.* By a similar process from Cowslip seed he could get only Cowslips and Oxlips, from which he concludes that the "hybridisation hypothesis wears an aspect of plausibility" ("Phytol.," iii. pp. 146–149). Godron, however, made the much more promising experiment of crossing and recrossing the two species, from which he raised numerous intermediate forms, which set the matter at rest. This question has been somewhat complicated by the fact that there is a true species, *Primula elatior*, Jacq., which somewhat resembles the hybrid Oxlip, and the two were formerly confused together. The species is now known as the Bardwell Oxlip. Mr. Miller Christy has published an exhaustive paper on the subject ("Journ. Linn. Soc.," xxxiii. pp. 172–201).

Some years ago in a batch of Sarracenias, imported by Mr. B. S. Williams, of Upper Holloway, a plant was found which combined the characters of *S. purpurea* and *S. flava*, and was named *S. Williamsii*. Mr. Stevens, of Trentham, crossed *S. purpurea* with *S. flava*, and his seedling was named *S. Stevensii*. The late Mr. T. Moore is said to have observed respecting them :—"These two plants have the same parents. . . . We have little doubt the crosses were made the reverse way" (Burbidge, "Cult. Pl.," p. 527). Recently a second natural hybrid has been recorded. Mr. G. W. Oliver remarks :—"An instance occurred under my own observation a few years ago in a well-marked *Sarracenia* hybrid which was found growing near Wilmington, N.C. Only three species were growing near the hybrid : these were *S. rubra, S. purpurea,* and *S. flava* ; in the hybrid the form of the leaves suggested *S. purpurea* as the seed-bearer, with *S. rubra* as the pollen parent. This surmise proved

* These specimens are preserved in his herbarium, now at Kew, and, having examined them, I can say that they are not true Primroses and Cowslips, which would imply complete reversion to the parent forms. Whether they are secondary hybrids with either parent, or partial reversions, is, of course, problematical.

correct, as under cultivation pollen from *S. rubra* artificially applied to the stigma of *S. purpurea* produced exactly the same hybrid as was found growing wild" ("Amer. Gard.," June 3, 1899, p. 400). It is further interesting to add that from the reversed cross Messrs. Veitch had already raised *S. Chelsoni* ("Gard. Chron.," 1880, xiii. pp. 722, 725, fig. 125).

Among Orchids a good many supposed natural hybrids have been proved artificially, the first being *Phalænopsis intermedia*, which will always retain a historical interest, as the first recognised hybrid among tropical Orchids, and the first whose origin was experimentally demonstrated, an interval of thirty-three years elapsing between the two events. It appeared as a single plant in an importation of *P. Aphrodite* (then known under the erroneous name of *P. amabilis*), received by Messrs. James Veitch and Sons, in 1852, from the Philippines, through their collector, Thomas Lobb, and was described and figured in the following year ("Paxt. Fl. Gard.," iii. p. 163, fig. 310) by Dr. Lindley, who remarked:

FIG. 93.—PHALÆNOPSIS × INTERMEDIA (Veitch's "Manual of Orchidaceous Plants.")

'It is not improbable that this beautiful plant is a natural mule between *P. amabilis* and *rosea*," and then proceeded to show its resemblance to both species. Years afterwards, when the raising of artificial hybrids had become an established business, Messrs. Veitch proceeded to test the truth of this hypothesis by crossing *P. Aphrodite* with the pollen of *P. rosea*, and the resulting seedling proved absolutely identical with the wild plant (Rolfe in "Gard. Chron.," 1886, xxvi. pp. 169, 212). The shrewdness of Lindley's observation will be inferred when it is remembered that *Calanthe* × *Dominii*, the first artificial hybrid among Orchids, did not flower until 1856.

In 1886, also, *Lælia* × *lilacina*, Rchb. f., from the collection of F. A. Philbrick, Esq., was described as a natural hybrid between *Lælia crispa* and *L. Perrinii*, the two species from which *Lælia Pilcheri* had previously been raised by Mr. Dominy, and although the former presented some slight differences from *L. Pilcheri*, Reichenbach remarked, "I believe it must be regarded as a variety of that mighty beauty."

In 1888 the origin of another natural hybrid Orchid was proved.

When *Masdevallia splendida* and *M. Parlatorea* were described, some ten years previously, Reichenbach had thrown out the suggestion that they might be natural hybrids, and Messrs. Veitch accordingly crossed together the two species with which they came home, namely *M. Veitchiana* and *M. Barlæana*, using the latter as pollen parent. In 1888 the seedlings began to flower, and proved identical with the wild hybrids, which were now seen to be simply forms of one.

The first artificially raised *Odontoglossum* flowered in 1890, and proved interesting on another account. It was raised by M. Leroy, gardener to Baron Edmond de Rothschild, of Armainvilliers, near Paris, by crossing *O. crispum* with the pollen of *O. luteo-purpureum*, and was named *O. Leroyanum*. It was, however, immediately recognised as a form of *O.* × *Wilckeanum*, which in 1894 had been described by Reichen-

FIG. 94.—ODONTOGLOSSUM × DENISONIÆ. (*Gardeners' Chronicle.*)

bach as a natural hybrid between the self-same two species, and soon afterwards it was traced back to 1872, when it flowered in the collection of Lord Londesborough, and was described and figured under the name of *O.* × *Denisoniæ*.

A year later Messrs. Veitch flowered a third hybrid which had been raised with the express purpose of proving the origin of suspected wild hybrids. This was *Odontoglossum* × *excellens*, described by Reichenbach in 1881 as probably a natural hybrid between *O. Pescatorei* and *O. tripudians*. The second parent suggested was obviously incorrect, as the characters of the hybrid agree much better with *O. triumphans*, and consequently the pollen of this was used in a cross with *O. Pescatorei*, which yielded offspring absolutely identical with the wild plant.

In 1892 Messrs. F. Sander & Co. also flowered a hybrid which proved the origin of a wild plant. It had been obtained by crossing *Cattleya intermedia* and *C. Forbesii*, and on flowering I immediately recognised

it as identical with *C. Kramcriana*, described by Reichenbach, in 1888, as a natural hybrid with this parentage. A seedling from the same batch which flowered in May 1891 was exhibited under the name of *C. Lowryana*. Afterwards it appeared that *C. fimbriata*, which was raised by M. Bleu, of Paris, and flowered in 1878, was identical. And there is a *Cattleya Isabella* described by Reichenbach, in 1859, as an ally of *C. Forbesii* and *C. intermedia*, having characters of both, which is probably identical. It flowered with Messrs. Booth & Sons, of Flottbeck, near Hamburg.

In 1893 *Anguloa* × *media* was added to the list. It was originally raised in the collection of the late J. C. Bowring, Esq., of Windsor, from *A. Clowesii* and *A. Ruckeri*, flowering in 1881, and seven years later an identical hybrid flowered with Messrs. Veitch. It afterwards flowered in the collection of R. H. Measures, Esq., of Streatham, among imported plants ("Orch. Rev.," 1893, p. 40), and as the parents are known to grow together one need not feel particularly surprised.

The following year hybrids of two other genera were added to the list, and in much the same way. The first was *Calanthe* × *Veitchii*,

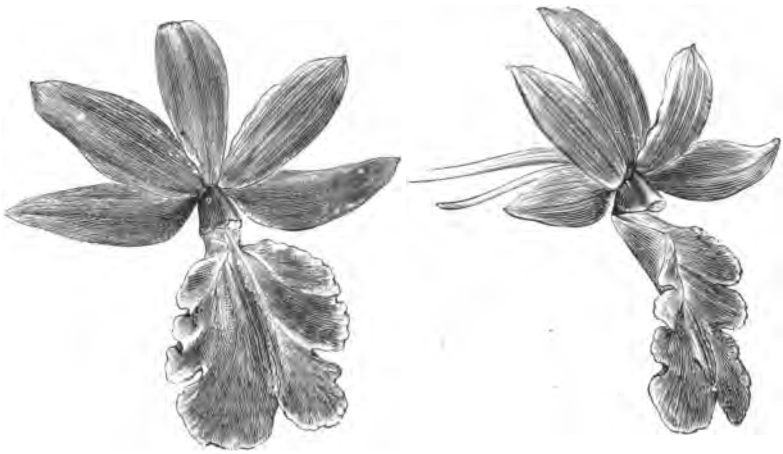


FIG. 95.—CALANTHE × VEITCHII. (Veitch's "Manual of Orchidaceous Plants.")

originally raised from *C. rosea* ♀ and *C. vestita* ♂ by Mr. Dominy, flowering for the first time in 1859, and afterwards detected in Burma, where the two parent species grow together, by Mr. Boxall. The latter flowered with Messrs. Hugh Low & Co. ("Orch. Rev.," ii. p. 19). Then came *Dendrobium* × *Rolfeæ*, raised by Messrs. F. Sander & Co., from *D. primulinum* ♀ and *D. nobile* ♂, flowering in 1892, and afterwards detected among imported plants of *D. nobile* in the collection of Major-Gen. Berkeley, of Southampton ("Orch. Rev.," ii. p. 114), and afterwards elsewhere. It has since been discovered that *D. Pitcherianum* was described by Reichenbach in 1888 as probably a natural hybrid between the same two species.

It is not necessary to continue the record further in chronological order, but it is curious to note that the nine hybrids already mentioned

belong to eight different genera. *Cattleya* at present holds the record in point of number of natural hybrids whose parentage has been proved. The second on the list is the magnificent *C.* × *Hardyana*, which originally appeared in 1884 in the collection of G. Hardy, Esq., and was afterwards artificially raised from *C. Dowiana aurea* ♀ and *C. Warscewiczii* ♂, by N. C. Cookson, Esq. ("Orch. Rev.," 1896, p. 298). Then came *C.* × *hybrida*, Messrs. Veitch's earliest hybrid Cattleya, raised from *C. Loddigesii* and *C. guttata*, and which afterwards appeared among imported plants with Mr. W. Brooks, of Weston-super-Mare ("Orch. Rev.," 1897, p. 333). *C.* × *Claesiana*

FIG. 96.—CATTLEYA × HARDYANA. (*Orchid Review.*)

was introduced by Messrs. Linden, of Brussels, some six or more years ago, and has now been raised by Mr. T. L. Mead, of Florida, from *C. intermedia* ♀ and *C. Loddigesii* ("Orch. Rev.," 1899, p. 72). And only yesterday I recognised among the exhibits of M. Charles Maron a plant identical with the natural hybrid *C.* × *Patrocinii* (see "Orch. Rev.," 1893, p. 343), under the name of *C.* × *Gaudii*. It had been raised by the exhibitor from *C. Leopoldi* ♀ and *C. Loddigesii* ♂. [Since this paper was written I have found the record of *C.* × *Russelliana*, raised by M. G. Mantin, of Paris, from *C. Warneri* and *C. Schilleriana*, which should prove identical with *C.* × *Whitei* (see "Orch. Rev.," 1899, p. 292).—R. A. R.]

Of the five or six distinct wild *Lælio-cattleyas* known, only one has been raised artificially—namely, *L.-c.* × *Schilleriana*, obtained by Messrs. Charlesworth & Co., from *Lælia purpurata* ♀ and *Cattleya intermedia* ♂ ("Orch. Rev.," 1898, p. 167). As a wild plant it has been known ever since 1855, in which year it was described as a species, under the name of *Lælia Schilleriana*. There are, however, seedlings in existence which ought to prove the parentage of two if not three others.

One other *Odontoglossum* claims a place in our list—namely, *O.* × *elegans*, described by Reichenbach, in 1879, as a natural hybrid between *O. cristatum* and *cirrhosum* ("Gard. Chron.," 1879, xi. p. 462). Messrs. Linden, however, have raised an identical hybrid by crossing *O. cirrhosum* with the pollen of *O. Hallii*. It flowered early in 1897, and was described

FIG. 97.—ODONTOGLOSSUM × ELEGANS. (Mr. Pollett's Catalogue.)

and figured under the name of *O. cirrho-Halli* ("Lindenia," xi. p. 85, t. 569).

Phalænopsis × *Veitchiana* appeared as a solitary specimen among Philippine importations of Messrs. James Veitch & Sons, and flowered in 1872, when it was described as a natural hybrid between *P. Schilleriana* and *P. rosea* (Rchb. f. in "Gard. Chron.," 1872, p. 935), a view since confirmed by Messrs. Heath & Sons, who have obtained it as a seedling from the former crossed with pollen of the latter (Hansen, "Orch. Hyb.," p. 331).

Lastly, and scarcely less interesting than any of the preceding cases, we have the remarkable fact that *Dendrobium* × *Ainsworthii* has

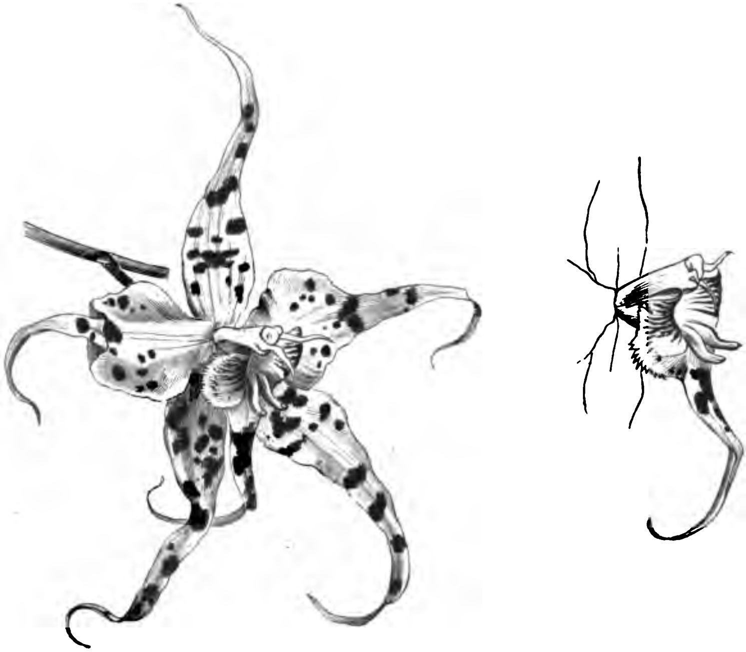


Fig. 98. - Odontoglossum cirrhosum. (Veitch's "Manual of Orchidaceous Plants.")

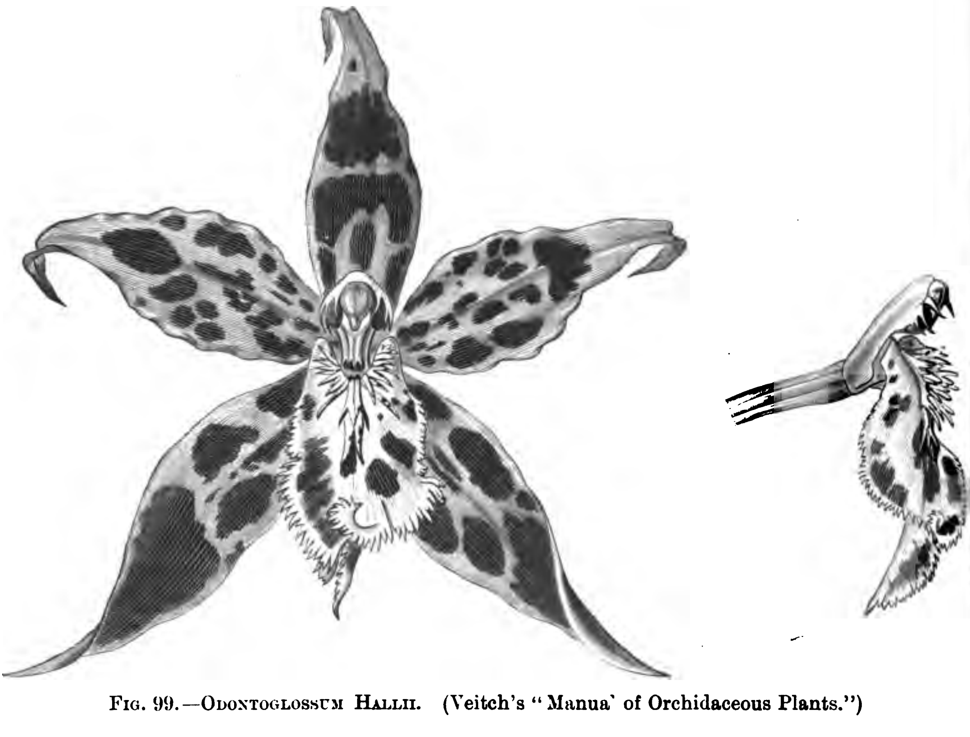


Fig. 99.—Odontoglossum Hallii. (Veitch's "Manua' of Orchidaceous Plants.")

Figs. 98 and 99 represent the two parents of Odontoglossum × elegans, figured on the preceding page.

appeared as a wild hybrid among importations of *D. nobile*. Examples of *D. aureum* also occur in the same importations ("Orch. Rev.," 1899, p. 99). Had the event occurred prior to 1874, when the seedlings which were obtained by Dr. Ainsworth by crossing these two species together flowered for the first time, the plant would almost certainly have been described as a species.

FIG. 100.—DENDROBIUM × AINSWORTHII. (*Gardeners' Chronicle.*)

At Chiswick yesterday plants were exhibited of a very curious hybrid Fern raised by Mr. E. J. Lowe between *Scolopendrium vulgare* and *Ceterach officinarum*, and which unmistakably combines the characteristics of these two species, which are remarkably distinct both in appearance and in the stations they affect. It is interesting to note that a wild hybrid between them has also been found, in Istria, and described under the name of *Scolopendrium hybridum* ("Kern. Nat. Hist. Pl.," ii. p. 582). I have not seen the latter, so cannot say how far the two are identical.

A question much discussed many years ago was the supposed development of cultivated Wheat from the wild Ægilops by cultivation. The facts, however, are briefly these. *Ægilops triticoides* occurs spontaneously in Southern Europe along the edges of Wheat fields, and for various reasons was supposed to be a hybrid between the Wheat and *Ægilops ovata*, a small grass which occurs there. Over half-a-century ago Faber grew this plant from a seed of *Æ. ovata*, and it was afterwards produced artificially by many experimenters, thus proving its hybrid origin. This hybrid proved mostly sterile, but at length, in 1838, Faber obtained a seedling which proved to be more like Wheat and more fertile, and by continuing

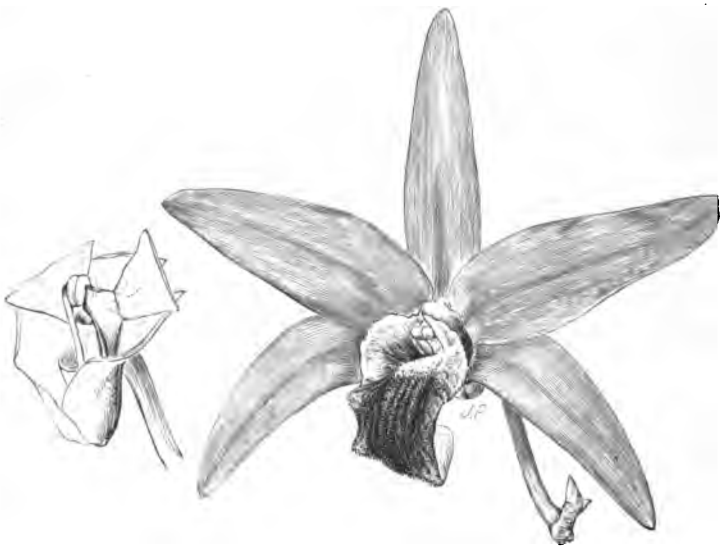


FIG. 101.—DENDROBIUM AUREUM. (Veitch's "Manual of Orchidaceous Plants.")

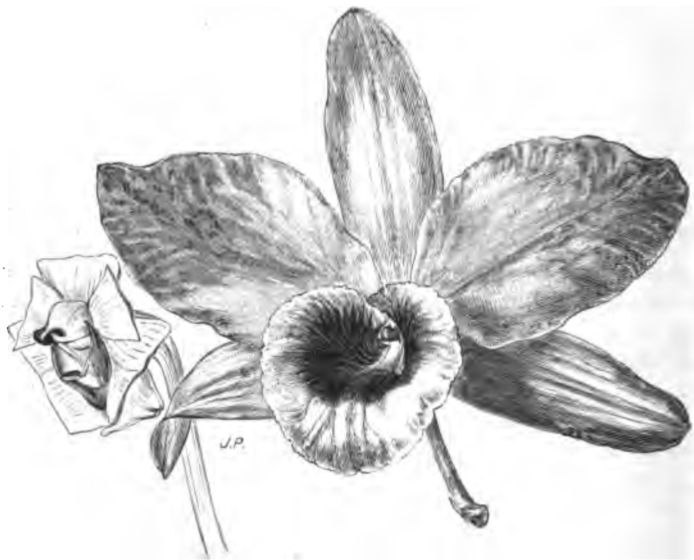


Fig. 102.—DENDROBIUM NOBILE. (Veitch's "Manual of Orchidaceous Plants.")

Figs. 101 and 102 represent the two parents of Dendrobium × Ainsworthii, figured on the preceding page.

the process he obtained a fertile race, which he called "Ægilops Wheat" (*Æ. speltæformis*, Jord.), and which, according to Focke, remained constant in character and fertile after being cultivated for a period of forty years.

I have discovered several curious records respecting hybrid Ericas. Mr. Andrew Turnbull, the well-known raiser of these plants, remarked in 1880:—"Many Heaths introduced from the Cape as species are in my opinion natural hybrids, as several varieties can be raised from the same pod of seed without impregnation." This is not very conclusive, but a little earlier we read:—"With regard to the hybridisation of Heaths I commenced that shortly after I came to Bothwell Castle. I was not then aware that Messrs. Rollisson, of Tooting, had practised it for twenty years before me, . . . and a short time after I saw a list of Heaths, said to be hybrids raised by them, and was surprised to see amongst them some we had always considered as distinct species from the Cape, and as such the date of their introduction, given in Loudon's Catalogue, ranging from eighty to one hundred years from the present date" ("Gard. Chron.," 1880, xix. p. 179). A note by Mr. George Rollisson in 1843 is interesting in this connection:—"My much-lamented father practised [hybridisation] upwards of fifty years ago: he confined himself principally to Ericas. . . . From the period he commenced, viz. 1790, until 1841 he succeeded in obtaining nearly ninety varieties," a list of which is given ("Gard. Chron.," 1843, p. 461). I spent some time in the attempt to identify some of these hybrids with wild examples, but without success, and anyone who likes to take the subject up will soon discover that there is the greatest confusion in the records. A remark on the subject by the editor of the "Gardeners' Chronicle" in 1880 is more eloquent than anything which I can offer:—"In the times of which Turnbull was speaking it was considered by a section of no doubt worthy people to be almost an impious thing to raise hybrid plants. It was deemed a sacrilegious interference with the laws of the Creator, and so strong was this prejudice in certain quarters that some of the nurserymen at that day were fain to conceal the hybrid parentage of the plants they offered, and to catalogue them as if they were imported species from the Cape" (1880, xiii. p. 177). No doubt natural hybrids occur, but their identification must be left for the present.

I may conclude these examples by a few remarks respecting two plants which are equally well known, both to botanists and horticulturists, namely, the Red and White Campions, *Lychnis diurna* and *vespertina*. Distinct as they are, both in appearance and in the stations they affect, there has always been a great difficulty in distinguishing them by any absolute characters. Linnæus in 1753 made them varieties of a single species, which he called *L. dioica*, enumerating a third variety somewhat intermediate between the other two ("Sp. Pl.," ed. 1, p. 437). Smith in his various writings adopted a similar course, and in 1824 he remarked: "No solid, permanent sign of specific distinction has occurred to me between α and β, though I have much wished to find one" ("Engl. Fl.," ii. p. 329). Both forms he showed to be common, but there was a variety with "flesh-coloured flowers" found "in hedges and fields, but rarely," which spoiled the distinction. Various other authors

had been troubled with this question, and in 1794 Sibthorp had classed the two as distinct; a view which had found supporters, when in 1818 the following remark appeared in print:—" Mr. Woodward recently observes that if the white and red be distinct the hermaphrodite variety with flesh-coloured flowers is probably a hybrid between them " (" Withering Brit. Pl.," ed. 6, ii. p. 570). This suggestion afterwards proved correct, for Gärtner in the summer of 1830 flowered a hybrid which he had raised artificially between the two species, to which he gave the name of *Lychnis dioica albo-rubra* (" Flora," 1831, p. 572). A year later he raised the reverse cross, which he called *L. d. rubro-alba* (*l.c.*, 1832, p. 446). The natural hybrid is widely diffused both in England and on the Continent, and was described in 1866 as *Melandryum intermedium* (" Schur. Enum. Pl. Transsilv.," p. 106), and a year later as *M. dubium* (Hampe, ex Garcke, " Fl. Deutschl.," ed. 8, p. 66), besides having also been considered as a variety of each of its parents. Even now the question seems imperfectly understood, and long after the wild and artificially raised hybrids had been identified together, we find Bentham writing of *L. diurna*:—" Very near *L. vespertina* and perhaps a mere variety." In 1863 Mr. Baker wrote:—" A plant is not unfrequent which looks like a hybrid " (" North Yorks.," p. 209). He also sent examples to Boswell-Syme, who was partially convinced, though one he thought was "only a pale variety of *L. diurna*, though, in the absence of the mature capsule, it is difficult to give a decided opinion " (" Engl. Bot.," ii. pp. 69, 70). Examples were also sent to Hewett C. Watson, and the latter both collected it wild in Surrey and perpetuated it from seed * in his own garden, as may be seen by a series of specimens preserved in his herbarium, though I cannot find that he ever published his views respecting them. The simple fact is that the two plants are thoroughly distinct in numerous particulars, and affect such different habitats that in some localities one or the other of them is completely wanting. But where their stations are adjacent they hybridise together very readily, and it is here that these intermediate forms occur which have puzzled botanists so much. I may add that in 1863 Godron also raised the hybrid from *L. vespertina* ♀ × *diurna* ♂.

The foregoing case is typical of many others. Natural hybrids have been largely ignored or got rid of by the following processes. Some of the more distinct have been described as species, the authors simply judging them by their characters, without knowing anything of their actual origin. Others have been treated as varieties of one of the parents, on account of resemblances too patent to be ignored. And, in a few cases, the presence of intermediates has led to the two parents being regarded as simply forms of a single species. Each of these methods has been applied in the case of the *Lychnis* just mentioned, but from the very nature of the case the results are contradictory and unsatisfactory. The only alternative is to assign to natural hybrids their true value, treating them neither as species nor varieties, and this leads us to ask the question, How may they be recognised? The answer is not easy, but a few

* A note on the sheet states that among the seedlings were forms with pink, white, and red flowers.

considerations will help us to realise their essential distinctness as a class.

A species may be described as a collection of like individuals inhabiting a definite geographical area, more or less continuously or discontinuously according to circumstances, and over which they have spread by diffusion from some original birthplace. Widely diffused species are generally variable, owing to modifications effected by change of environment, which eventually result in the production of distinct but allied species, mostly in distinct geographical stations, though by subsequent diffusion their areas may again overlap. Many of these allied species retain their congenital affinity, yielding hybrid offspring when intercrossed, and when such species grow in proximity to each other the pollen frequently gets transferred by natural agencies, and under such conditions natural hybrids frequently occur. Hybrids—natural or artificial alike—almost invariably show a distinct combination of the characters of the two parent species, which may usually be traced on careful examination, though sometimes the influence of one parent preponderates to such an extent that it becomes difficult to identify the second one. They are usually very variable, some individuals derived from the same two species being so dissimilar as to have been at first considered essentially distinct in their origin. Those which occur wild are usually found intermixed with the parent species, though in the case of wind-borne seeds this may not always apply. And they are frequently rare, as compared with the parents, though some species hybridise with such facility as to form notable exceptions.

These are, of course, only relative peculiarities, and afford no clue to the identification of a hybrid *as such*. The fact is no absolute differential character can be pointed out. It was formerly thought that hybrids between distinct species were universally sterile, and consequently a so-called "fertile hybrid" was taken as evidence that the parents were only forms of one; a view which long ago proved altogether untenable. We now know that some *bonâ fide* hybrids are as completely fertile as their parents, and even those that are sterile—*i.e.* have their reproductive organs functionally impotent—frequently appear structurally perfect.

It is this absence of any reliable character by which a hybrid can be recognised that constitutes the real obstacle to progress in our knowledge of "natural hybrids." It is open to every sceptic to ask for "proofs," and we have already seen how the views of many shrewd observers have been treated. It is not always sufficient to point out that such and such a plant is rare, is only found where two other species grow together (not where they grow separately), that it is intermediate in character, or that it combines the characters of the two, and is evidently a natural hybrid between them. The test of direct experiment is alone convincing in many cases, and believing, as I do, that natural hybrids are more common in certain groups than we have yet realised, I welcome any additional light that can be thrown on the subject, from whatever source it may come; and instead of viewing the work of the hybridist unsympathetically, I only wish some of his energy could be diverted into other channels, for I believe that nothing would do more to advance our knowledge than a few well-directed experiments in those groups in which so much difference

of opinion exists. I need not enumerate them further, and I believe that a deeper search among the scattered records would add several to the foregoing list of those whose origin has been demonstrated experimentally.

There is one question remaining on which I should like to say a few words, and that is whether the question of hybridisation may not have to be considered even in connection with the very origin of species. Kerner answers the question whether "species" are ever produced by hybridisation in the affirmative, and adduces some very important evidence in support of this view. In discussing it we need not go into the vexed question of what is a species. We may take it that they exist, and for the sake of clearness may adopt the Darwinian conception that they have arisen by gradual divergence of character from a common ancestor. We have already seen that certain hybrids are fertile, and can be reproduced true from seed for years in succession. We may therefore term them "hybrid races," but we may ask, in what respect, apart from their origin, which is known, can they be distinguished from certain "species," universally recognised as such, whose origin is not known? If difference there be, we are not yet able to define it in words.

Kerner, in his "Natural History of Plants," has given some interesting particulars about these hybrid races, from which we may make a few extracts. A hybrid between *Medicago falcata* and *sativa*, known as *M. media*, is widely cultivated as a fodder plant, and is propagated from seed (vol. ii. p. 577). *Salvia betonicæfolia*, a hybrid from *S. nemorosa* and *nutans*, is as common as its parents in grassland in Central Hungary (p. 585). *Betula alpestris*, a hybrid between *B. alba* and *nana*, is abundant in the Jura, Scandinavia, and in North Russia, here and there whole copses of it being found (p. 586). *Nigritella suaveolens*, a hybrid between *N. angustifolia* and *Gymnadenia conopsea*, is abundant in some Swiss localities, hundreds of plants sometimes occurring in a single meadow (p. 586). Hybrids between the Primrose and Cowslip occur in thousands in upland meadows in the Eastern Alps (p. 586).

Rhododendron intermedium is a particularly interesting hybrid. In some localities in the Tyrol there is a great variety of soil, and a very rich flora, plants peculiar to schist formations and others found only on limestone growing close together. *Rhododendron ferrugineum* and *R. hirsutum*, though peculiar to these formations respectively, thus exist here side by side, and intercross freely, the hybrid in some localities being commoner than either parent. It seeds freely, and comes true from seed, and thus fulfils all the requirements demanded of a species, being as much a specific entity as either parent. The explanation is that the flowers are a little lighter than those of *R. ferrugineum*, but richer than *R. hirsutum*; in fact, a brilliant carmine, which enables every plant to be identified at a distance. It is thus more attractive to bees, and gets fertilised with its own pollen. In some localities, where detritus from the limestone occurs mixed with humus, the hybrids do better than *R. ferrugineum*, and as well as *R. hirsutum*, so that it has an advantage over the former in the matter of soil, and over both parents so far as insect visits are concerned. It has thus a better chance of surviving (p. 588).

Salvia sylvestris, a hybrid from *S. nemorosa* and *pratensis*, abounds in dry meadows all over the low country south of Vienna. It is an undulating country, with elevations of boulders and clay. On the rising ground and gentle slopes, *S. nemorosa* is the prominent feature, but in hollows of black earth and humus *S. pratensis* luxuriates. The two kinds of habitat pass into each other gradually, those common to both consisting of dry meadowland in which the former parent does not thrive, and is seldom seen, while it is too dry for *pratensis*, which is also poorly represented. But the hybrid, being intermediate in character, thrives there exceedingly; is much visited by insects; and ripens seeds as well as either parent, of which experiment has shown that 60 per cent. are fertile. Thus the hybrid, which is scattered all over this meadowland, manifests all the characteristics essential to our conception of a species (p. 588).

Nuphar intermedium, a hybrid from *N. luteum* and *pumilum*, occurs in lakes in the Black Forest and in the Vosges, in scattered localities of North Germany, Central and North Russia and Sweden, and as far north as Lapland, in the north being more abundant than either parent—in fact it passes their northern limit, and occurs without them. Here it multiplies from seed without change of form, and in fact has established itself, to all appearances, as a species; yet its origin has been proved by artificial crossing. The reason why the hybrid has been able to extend its range further north is that it matures seeds in rather shorter time than either parent, and thus we may say that the northern limit of each is determined by its ability to ripen its fruit. *N. luteum* flowers last, and is the last to ripen its seeds; consequently as we proceed northward we find that it is the first to fail. *N. pumilum* ripens a little earlier, and consequently gets a little further north, while *N. intermedium* is able to extend itself beyond either. As, however, hybrids can only occur where the parents grow together, it is clear that the extension of *N. intermedium* northwards beyond the limits of *N. luteum* has been by its own seeds, and there at all events it is autonomous (p. 589).

Sometimes a hybrid is found in company with one parent only, or with one in one locality and both in another; sometimes even where both are absent; and this may either be due to diffusion from the original birthplace, or, in some cases, to displacement of the parents by changed conditions. In fact, a hybrid which is fertile with its own pollen may easily extend its range if conditions are favourable, and thus originate a hybrid race, which, as we have seen, may present all the essential characteristics of a species. I do not, however, propose to call them "species." They have certainly not arisen by divergence of character, but rather by the sudden fusion of essentially distinct branches, forming points from which new branches may themselves arise. Here, then, is a new factor in the branching of our genealogical tree, or, at all events, one which has as yet only been very imperfectly realised, and it emphasises the importance of the subject under discussion to all systematists who wish to go beyond the mere identification of their plants.

To what extent, then, does hybridisation occur in nature? Kerner estimates that something like a thousand natural hybrids have been found in Europe during the last forty years, and there is no reason to

suppose that this Continent enjoys special facilities in this respect. Floral contrivances for promoting cross-fertilisation lead to a constant transference of pollen, for we know that insects in their search for food are indiscriminate in the flowers which they visit, and this circumstance leads to a constant origination of hybrids wherever allied species capable of intercrossing grow in close proximity. Their production is largely a question of opportunity, for, as we have already seen, some have originated spontaneously in gardens where allied species from different localities have been planted together. And there is *Erigeron Hubsenii*, a remarkable wild hybrid which has originated between the European perennial *E. acer* and the introduced annual *E. canadense*, which furnishes an excellent example.

Of these hybrids only a fraction survive and multiply. In the first place they may be sterile, or if fertile they are liable to be swamped by recrossing with the parent stocks. They may even be less suited to the conditions under which they find themselves than either parent. The establishment of a hybrid race is dependent on certain circumstances. It must be fertile with its own pollen—that is with pollen of the same hybrid stock—and it must be in harmony with the conditions of its habitat. It has to enter into a struggle with the species already there, and particularly with its parents, and only if as well or better fitted to its environment will it make successful headway. In a few cases, as we have already seen, it may grow apart from either parent, and encounter new conditions of soil or climate which specially favour it. Under such a combination of circumstances hybrids may become dominant, yielding hybrid races.

Viewed from this standpoint the phenomena of hybridisation acquire a special significance to the systematist, and a knowledge of the behaviour of artificial hybrids under cultivation, and the relation they bear to their parents, should help him greatly in the identification of those which occur spontaneously in a wild state. And a correct idea of the existence, behaviour, and distribution of natural hybrids where their life is untrammelled should throw further light on the very origin of species. We need not follow the subject into the regions of pure speculation, but if hybrid races exist in the present they may have done so in the past—a nice little problem for speculative geologists to tackle.

A knowledge of garden hybrids, however, will not enable us to understand or recognise all those which occur in nature, and various problems will have to be investigated by direct experiment, the results of which will throw further light on a most important but perplexing and intricate subject.

I think I have said enough to vindicate the opinion of Dean Herbert, expressed over three-quarters of a century ago, that hybridists would not confuse the labours of systematic botanists. Indeed, in the words of Mr. C. C. Hurst, "artificial hybridisation, which it was supposed would lead systematic botany into the direst confusion, by the irony of fate seems destined to be the only trustworthy means of saving systematic botany from its own confusion, and the systematist, however orthodox he may be, can no longer afford to ignore artificial hybridisation." The foregoing facts, I think, fully warrant the conclusion.

ON SOME HYBRID POPPIES.

By Monsieur Henry de Vilmorin.

The series of hybrid Poppies, of which I purpose to give a short account, originated at Verrières, near Paris, in the year 1890, in consequence of a cross repeatedly performed between *Papaver bracteatum*, L., seed-bearing parent, and a double garden variety of *P. somniferum*, L., which supplied the pollen, a striking feature in the case being that one of the parents is an annual and the other a perennial plant.

The great discrepancy in the respective characteristics of both parents affords an easy means of recognising the fact of the blending of the species and of appreciating the relative share of influence of either parent in each individual hybrid plant.

The first batch of seedlings raised from the original seed-pod showed a very remarkable uniformity of appearance. All the plants were annual, with a distinctly glaucous colour on leaves and stems, plainly inherited from *P. somniferum*. From the same parent they derived their branching habit. From *P. bracteatum* they received the strong hairs on their stems and leaves and the great size of their flowers, which were constantly single, and showed variation only in the fact of some of them having the edge of the petals fringed or laciniated, while in the greater number it was plain and smooth. The colour was a deep rich crimson, with a dark blotch on each petal, the influence of the common annual Poppy asserting itself again in the departure from the fiery scarlet of *P. bracteatum*. In height the hybrid plant surpassed both its parents. The plants in this first generation bore no seed.

A fresh trial was made in 1892 with seeds kept over from the original capsule. They came up freely, and several beds were planted with the seedlings, which developed into plants quite similar to those raised the year before. A few plants showed some tendency to take a perennial habit. Some seed was saved this time, although in very small quantity, and from the annual plants only.

This became still more marked in the next generation, when some plants visibly reverted to *P. bracteatum*, but were found entirely barren, while the annual plants, with the plain stamp of *P. somniferum* upon them, commenced to set seed more freely.

From the first some slight variations were observed in the colour and shape of the flowers, which, by selection, were brought to reproduce themselves in a fair proportion. Roughly speaking, one might divide them into three sections:—

(1) Bright crimson, the original shade of colour, with large, strongly marked black blotches; single.

(2) Light, delicate pink, with the blotches much less distinct than in No. 1; single.

(3) Double flowers, never very full, but showing a bunch of entangled narrow petals in the centre, not concealing the broad blotched outer petals.

Such are for the present the principal variations issuing from the hybrid Poppy just mentioned. They are all annual, and partake more or less of the glaucous colour of *P. somniferum*. They were introduced into trade collections in 1895, and are useful as showy annuals.

But a new departure was recently effected by pollinisation of the original hybrid plant by a distant race of the maternal *P. bracteatum*, known in gardens as the Tournefort Poppy, which differs from *P. bracteatum* by the absence of the leafy bracts under the corolla and by an orange scarlet instead of a deep blood colour.

The effect of the new cross was to bring back the plant to a perennial habit of growth; to breed the glaucous colour out of it to a great extent, while retaining the branching character of the stem. A perpetual growth of flowering stems was also induced, in consequence of which the new cross promises to be a valuable hardy plant for the garden, being a perpetual bearer of large bright flowers during all the summer and autumn. It is quite hardy, and being planted out in September stands the winter perfectly, and blooms profusely from May till October. The colour of the flowers is a bright scarlet, somewhat verging to orange, with petals either plain or blotched: they are large and showy, but naturally rather smaller in the more branched plants.

Some other crosses were attempted, mainly with *P. pilosum*, Sibth. and Sm., and *P. glaucum*, Boiss., which were manifestly successful, but up to the present day failed to produce seeds, and are consequently confined to the domain of botanical curiosities, while both the annual and the perennial forms of the hybrid Poppies just described may hope for a successful career amongst the objects of ornamental gardening.

The Chairman: I am sure everybody here will thank M. de Vilmorin for his important communication. As he observes, a cross between two species, one perennial and one annual, is of great rarity and of particular interest. The attempt at crossing between Sunflowers, one perennial and one annual, some time ago was a complete failure. I do not know whether it has since succeeded.

M. de Vilmorin: I may add, several other crosses were attempted with different kinds of Poppies, but only in this one case I came to a definite result, and obtained something that might be of interest and use. Most of the other attempts failed in the sense that they gave no seeds by which to reproduce the hybrid. From many of those we crossed we obtained plants, but plants that were entirely barren.

The Chairman: We still have half-an-hour, and it is suggested that we should have a general discussion, not limiting our remarks to anything we have heard at the Conference, but taking in any point that may strike any member. If you will allow me I will start the ball with a few remarks. I would make an observation upon photographs of the microscopic structure of hybrids. Perhaps many persons have seen Dr. MacFarlane's drawings showing how you get a strict intermediate. Just now Dr. Wilson told us it was a difficult thing to study them where you got complex hybrids. Dr. MacFarlane only dealt with primary hybrids. I have studied those Rhododendrons which Mr. Veitch has raised, and went minutely into them and examined them microscopically. But nothing

came of it. There was not a single feature showing any structural difference between any two. Perhaps there was a little difference in the fibre of the vascular stock, but nothing like Dr. MacFarlane's illustration. I think the remark of Dr. Wilson's holds good where species are alike in their structures. We note that species differ if they come from widely different localities. A species growing in the desert or in Alpine regions compared with one growing in marshy land exhibits a wonderful difference. Where you get plants from widely different localities you expect to find these differences well pronounced in the microscopic structure. The Rhododendrons I examined all came from the same district, and there was no difference that I could discern in their anatomy. Yet some of them contained four or five species, and were very complicated in their structure.

Mr. F. W. BURBIDGE: Before we close this most interesting Conference it would perhaps be advisable if we entered to some slight extent into the question of the nomenclature of hybrids. When we held the Narcissus Committee—in 1884, I think it was—there was a resolution passed that the plants should not receive Latin names. We all know that the adoption of Latin names for hybrids has been a source of extreme trouble from the very first commencement of plants being hybridised. In olden days they raised Calceolarias, Pelargoniums, Fuchsias, &c., and they all got Latin names. The consequence is that to-day you find these names in botanical books, and the parentage is kept back, and the consequence is that utter confusion exists. We really do not know a tenth part of what we ought to know of the hybridisations of the past, owing to the Latin names being used in the same way for hybrids as for real species. Dr. Masters some years ago struck a very good note when he named a hybrid, raised by Mr. Veitch, Philageria—a compound of the names of the two genera that were united in the cross. The same plan is now carried out in other places. Sir Michael Foster was lucky in hybridising Iris, and very often he adopted the two specific names or a portion of the two names. Iris Monspur was a cross between I. Monnieri and I. spurius. To a certain extent this principle works fairly well; but I really think that we should go further to the root of the matter, and do away with the Latin names altogether for hybrid and garden plants. I think if we passed the resolution adopted by the Narcissus Committee, only making it apply to all plants, we should meet the case.

The Rev. G. H. ENGLEHEART: There is one subject of very practical importance that has not been touched upon at this Conference, but which ought to receive some attention. One feels that the subject of hybridisation is so enormous that at a Conference of this sort, even of two days' duration, one cannot possibly traverse the whole ground. I think it may be well just to hint at a line that may be taken up on a future occasion, and which I think would be of great practical value. Dr. Masters showed us very lucidly in opening the Conference that this was an era of hybridisation. Nowadays plants are made. And we know that life is short, and that the art of hybridisation is very long indeed. When the gardener, the practical man, establishes a business—the man whose money is in his gardening—he feels a certain reluctance to attack plants of which he

will not see the bloom, or the fruit, or the pecuniary recompense. It is, then, all important that the gardener, both the amateur and the professional—but the professional especially—should have every assistance; assistance, I may say, internal and external, equipment all round, and in the best way for the furtherance of his work. To begin with, we very much want something in the form of an easily intelligible handbook, which shall summarise the work already done in hybrids, so that every man shall not have to go over the same ground again. I have found there is an immense amount of waste of labour. In my own small work I have found that a great part of my time is wasted; for if one only knew the results of what others had done, or if we could only know what statements one reads are true and what are false, we should save a very great deal of time. I remember when I started with Narcissi I got hold of a book that told me to tie up the trumpets of my flowers to prevent insects crawling into them. I remember doing this—tying up the mouths of the trumpets. I never got any seed at all that year. No doubt that is a thing which should be known. The flower is a very complicated thing, and all its parts have meanings; and if you tie it up or cut off your corolla, you probably lose your seed. It would be a great help if these sort of things were generally known. In reading Darwin's work on cross-fertilisation, I was very much struck with one phenomenon. In one of his experiments with Dianthus he found the strain lost vigour and reproductive power. He crossed it then with a plant from his own garden, and the strain began to recover tone and strength. Then he went further, and crossed this variety with a plant from a distance, and he found that the infusion of blood from a distance gave still greater freshness and vigour. He got more seeds and stronger plants. Fortunately for myself I acted upon that, and I could see quite distinctly the good of putting fresh bulbs from a distance into my ground and writing to my friends at a distance for pollen. If we had a little handbook where these notes could be published, it would be a great help to us. It is very difficult to glean here and there from the pages of newspapers the information one requires. Here is another practical suggestion. Supposing a man who lives on his nursery raises, we will say, a good Peach, and a year or two after, when he has a good stock of that Peach, there comes a pecuniary pinch, and he has to sell his stock. He sells his stock, makes £50 or £100 by it. How much is it needed that a man should have some sort of patent rights during his lifetime in the fruit of his brain and industry! It is very hard that a man should be able to write a book and draw an income from that book, but that if he produces a plant that enriches the garden, or orchard, or nation, the year after he has produced it it is all over the kingdom, and everybody has as much gain from it as he has.

Mr. George Paul, V.M.H.: I should like very much to fortify what Mr. Engleheart has said. I do think it is a very hard thing that when we look round and see the work our English and foreign hybridists have done to feel that the work is so unremunerative. Perhaps in fruits it tells more, because these are articles of more commercial value. Take the Cox's Orange Pippin, an Apple to be found in every fruit garden in the world. The man who originated the Cox's Orange Pippin, I believe, did not make a penny out of it. I can speak with personal knowledge, having

been a raiser of Roses. I have communicated with others and have found that for all our trouble as Rose raisers our practical benefit has been almost nil. We have worked for honour and glory. That no doubt is a great thing. It is a grand thing to have your name handed down as a benefactor of the human race. But if the same pains, the same work, the same intelligence, had been given in any other profession or trade, in all probability men who had done equally good work would have reaped considerable pecuniary reward. I think the time has almost come when the Legislature should give some form of protection to the producers of such good things. I certainly think the labourer is worthy of his hire. I have talked it over with others, and it does not seem to me impracticable that some form of protection should be given to the man who has raised and distributed a new plant. He should have at least two, three, or four years of protection. It is a right given to other people—the right of private manufacture. A man who makes a screw which twists a trifle easier is protected by the Legislature, which gives him for many years the sole right to make that screw himself, or to receive payment for allowing other people to produce it. I am very glad that the original suggestion on this matter came from a man who has no interest in the trade like myself; but I have felt it so keenly, and I am sure that other raisers have also, that it seems to me at the end of a Conference such as we have had it was fitting that the subject should have been introduced. I, personally, as a raiser and a tradesman, thank Mr. Engleheart very warmly.

Mr. George Bunyard, V.M.H.: Mr. Engleheart has introduced a subject which, of course, is of very great interest to all of us, and he has started a discussion on the commercial aspect of horticultural questions. I am not a botanist; I am not a scientist; I am a commercial man; and I think the whole thing lies in a nutshell. It surely remains with the person who raises a thing to sell it at his own price. It seems to me a very simple thing. Say that I raise a new Apple; it seems to me as easy a thing as can be if I want to make £100 out of it that I should raise a sufficient stock which at 5*s.* apiece will bring me in that amount. All I should have to do would be to say, "I have brought out a new Apple. I am willing to distribute it at 5*s.* a piece, and I do not intend to let it go until I have sufficient orders for it to pay me for my trouble." The idea of having patent rights in a thing that can be so easily and readily propagated seems to me not only in the highest degree improbable to be attempted, but impossible to be secured by any legislative action. What power can possibly prevent distribution? A head gardener might throw a cutting or a root on a rubbish heap and his assistant might go and give it to a friend. You cannot follow it up and prevent it. The subject has frequently been discussed between Mr. Rivers and myself. I told him, "You have been disinterested almost to the point of folly; you have practically given away plants of enormous commercial value." But he could not blame me. I had bought the things of him, and I had given him whatever price he asked for them. The remedy is to put a sufficient price upon a new plant when you first part with it; and on those lines the whole thing seems to me a very simple commercial matter, requiring no patent rights whatever, save those which each man can manufacture for himself.

Dr. Masters: When I had the honour of opening this Conference yesterday I told you we were about to discuss a most important subject. I am sure you will agree with me that I was right. I told you also there were a great many difficulties and knotty problems. We have taken a survey of a wide field to-day and yesterday, and have even ended by considering trade rights and patent rights and copyrights. I think the outcome of our Conference is this: There are difficulties to be solved. There is a difficulty in reconciling the practical man and the purely scientific man. But I would ask of all present whether we have not solved it. They have only got to "cross," and all our difficulties will be solved.

Mr. Willet M. Hays, U.S.A.: I do not know that there are others here who represent experimental stations, but I believe the time has come in America, and will come in other countries, when the experimental station shall take up this question of the sending out of new plants as one of their duties. The originator then will get a chance of having his creations placed before people at a proper remuneration to himself. I should like to ask whether we are going to continue the delightful discussions of the last two days at some future time and at some other place. Are you going to France next year, or will you come over to America? I feel a little delicate about suggesting these things, but if you would come to us I would promise you a right-down hearty welcome.

The Chairman: With reference to the subject opened by Mr. Engleheart, I have not a word to say, being a scientist pure and simple. I see the difficulties, although perhaps Mr. Bunyard's suggestion may settle it. When you start a new plant and spread it about in the country it very often changes its characteristics slightly in different localities, and if propagated from that locality it would not be *exactly* the same plant as that from which you started. How far you would be able to guarantee the same form, or to prevent the distribution of the slightly different local form, it would be difficult to say. Before concluding, I think we must thank those gentlemen, especially those foreigners who have come so long a distance to help us, for the interesting papers they have given us. When we get the papers printed in our Journal we shall be able to study them at our leisure. How far it will be desirable or practicable to carry out a Conference in another country—whether in Germany, France, or America—it is impossible for me to say at the present time; but it is a suggestion worth thinking about. I beg to thank you all in the name of the Royal Horticultural Society.

COMMUNICATIONS SENT TO THE CONFERENCE.

HYBRIDISATION IN THE UNITED STATES.

By Professor L. H. Bailey, Cornell University, Ithaca, U.S.A.

In considering the status of hybridisation in any country two courses are open to the reviewer. He may make an inventory of the specific experiments in hybridisation with discussions thereon, or he may attempt a bold summary of the results. One is the method of details; the other is the method of conclusions. It is this latter method, I take it, which your Secretary had in mind when he asked me for a short paper on hybridisation in the United States. I therefore attempt, with few sentences, to express judgment upon the progress of hybridisation in this country, upon the present status, the tendencies, and the prospect.

It is first of all necessary that the European reader should know that the standards of judgment are unlike on the two sides of the Atlantic. This is because the natural and economic conditions are unlike in the two continents. Relative to the entire area, intensive gardening is less frequent in America than in Europe. There are, relatively, fewer glass-houses. There is less interest in individual plants. There is less of the amateur's instinct. On the other hand there is, relatively, more large-area horticulture. Fruit-growing has developed farther than elsewhere in the world. There is relatively greater interest in cosmopolitan varieties—in those which are adapted to wide ranges of conditions. It is therefore evident that there must be less interest in hybrids merely because they are hybrids; for hybrids are valued most where there is the greatest number of fanciers, or the most persons who grow plants for the intellectual interest in the individual specimen.

Again, the interest in individual plants is gratified in small gardens, in which the conditions are under control. The varieties of Europe can be grown in these gardens. Glass and water and shade and highly fertile soil and skilled labour will grow almost any plant. Our taste for the choice horticultural rarities and curiosities is supplied very largely by varieties of European origin. We buy your hybrids, and I am sure that you would not have it otherwise. The highly bred Cannas, Tulips, Roses, and many other plants are as frequent and as good in American gardens as in European; but the greater number of them are of European origin.

Our great problem is to make the country productive. There are as many different climates and physiographical conditions in the United States as in the whole of Europe. The plants must grow in the sun and the rain and the drought, and be able to hold their own. There are great stretches adapted to fruits and vegetables and flowers. These areas must

be filled. In this you cannot help us, except in so far as you give us the orginal stock upon which we are to work.

It is in the development of great new races of fruits that the American has made immense strides in plant-breeding, and some of this breeding has been by means of hybridisation. How great this experiment has been we ourselves have not realised; but it is certainly beyond contradiction to say that the last fifty years have produced greater results in the breeding of fruits in America than has ever been witnessed in the same length of time. These experiments have been on so large a scale, and the results have been so far-reaching, that they almost eclipse the many attempts at the production in this country of mere hybrid plants.

Our fruit growing may be said to be endemic. The European type of Grape (*Vitis vinifera*) is grown in California and some other places; but the Grape interest of the larger part of North America is developed from our native species. Great numbers of the varieties are hybrids, some of them between the native species themselves and others between the natives and the European or Wine-grape stock. Many of these hybridisations were undesigned, but there are notable exceptions. Several experimenters have made direct attempts at the amalgamation of the species, and each one has had a distinct and personal ideal. The eastern hybridists have sought to introduce the Wine-grape blood into the native stock. Of such are Rogers, Haskell, and Ricketts. Some of Rogers' hybrids are now amateur and commercial Grapes of high standing, as the 'Agawam,' 'Lindley,' 'Salem,' 'Wilder,' and 'Barry.' The western hybridists have sought a closer amalgamation of native species and varieties, although most of them have used more or less dilute Wine-grape blood. Jacob Moore has produced the 'Diamond,' a Grape of much importance and promise. Rommel and Jæger and Munson have worked with the species of the mid-continental region; and Munson, in particular, has bred with the excellent and variable *Vitis Linsecomii* of the post-Oak regions of the south-west. Wylie has attempted the amalgamation of the southern Muscadine (*Vitis rotundifolia*) with the northern types. Waugh has estimated that 42 per cent. of our varieties of native Grapes are hybrids or crosses. There are certainly more than twenty native species or varieties of Vitis in the United States, and several of them will unite to produce the Grapes of the future.

While the Grape has been the most prolific field of hybridisation experience in the western world, it is difficult to say what fruit occupies the second place in this respect. The most marked departures have occurred in the Plums, but the results are not yet of such commanding commercial importance. The European type of Plum thrives from the northern Allegheny region to the Atlantic, along the Great Lakes, and on the Pacific slope; but in the wide continental plain and in the South it finds only a precarious existence. In this great region there are several native species of Plums, and two or three hundred cultivated and named varieties have already arisen from them. Many of these varieties are of hybrid origin. In fact, there is a whole class of hybrid Plums which is so unique that the group has been described as a species, *Prunus hortulana*. To this class belongs the 'Wild Goose Plum,' which is a staple variety in the interior country. The Japanese Plums (*Prunus*

triflora) have become widespread and popular within the last thirty years; and now a new race of hybrids between these and the natives is appearing. Thirty undoubted Plum hybrids have been studied and tabulated by Waugh, and as many as seven species are represented in them.

A somewhat parallel evolution is taking place in Apples. The Prairie States Crab (*Pyrus Ioensis*) has hybridised with the common Apple, producing a race which has been described as a species. These hybrids promise something for the mid-continental region. But perhaps the largest crossing experiments ever made in North America is in the amalgamation of various races and varieties of *Pyrus Malus*, in the hope of securing adaptable varieties for the western Mississippi valley and the cold North. The Russian races and the Siberian Crab (the latter, *Pyrus baccata*) are some of the stocks which have been used. Budd long ago began this crossing work, and some of the seedlings are now bearing at the Iowa Agricultural College. To give an idea of how extensively this work is prosecuted, I may say that Craig made over 5,000 Apple crosses in Iowa in 1899. For one thing a man was sent to Arkansas, a distance of 500 miles, to collect pollen of given local varieties, and this was used on the Iowa flowers. This work is systematised between the Iowa Experiment Station and the fruit growers of the State.

The European Pear does not thrive in our Southern States. But a new race has made Pear growing profitable there. This race is the product of several hybridisations of *Pyrus communis* and *Pyrus Sinensis*. Of this race two varieties, the 'Kieffer' and 'Le Conte,' are widely planted. The acres upon which they are planted are counted by the tens of thousands. The 'Kieffer' is now the leader. It is a poor Pear in quality, but it is immensely productive, handsome, and a long keeper, and it sells well in the open market. This mongrel race has made Pear growing possible over an immense region. It must rank as one of the great hybrids of the world.

Our large Orange interests are on a European foundation. But the trees are not sufficiently hardy. For the improvement of the Orange in hardiness very significant experiments have been begun by Webber and Swingle, of the National Department of Agriculture, in amalgamating *Citrus aurantium* and *Citrus trifoliata*. The results are promising; and it will not be a surprise if the next great advancement in fruit-breeding is made in this direction.

There are important hybrid races in Raspberries and Blackberries, and in several other fruits.

The establishment of the experiment stations twelve years ago gave an impetus to the study of plant-breeding problems. The number of experiments is very large, when considered in the aggregate, but it is yet too soon for measurable results. Some of the efforts in plant-breeding, in which crossing is playing an important part, are those on the Apple by Craig in Iowa; on the Plum by Waugh in Vermont; on the Orange and Pineapple by Webber and Swingle; on Maize in Illinois and Kansas, and elsewhere; on Cotton in Georgia and Alabama; on Strawberries at the New York State Station and elsewhere; on Wheat in Kansas, Minnesota, and elsewhere; on cucurbitaceous plants at Cornell; on many

fruits at Ottawa and other places in Canada; and in many other directions by various experimenters. Various private individuals, as Munson and Burbank, are making useful experiments along similar lines and on a commercial basis.

Another fruitful class of experiments, although not strictly hybridisational, are those which have to do with the influence of crossing upon the set of fruit. Studies in this direction have proceeded far in America, having been set on foot by the investigations of Waite and Fairchild.

While pomological interests are paramount and often unique, distinct advancement has been made in many other types of plants. The most notable example is the carnation. The winter or forcing carnation or clove pink (*Dianthus Caryophyllus*) has developed into a new type in North America, and the evolution has come about within a generation. An important part of this progress has arisen by means of crossing. Other flowers have received attention from the hybridist, but in no other, so far as I know, has the American established a well-marked and dominant race.

In nearly all these instances hybridisation has been a means rather than an end. It induces variation. It is the beginning of plant-breeding: selection is the continuation of it. This is a fundamental principle. Hybridisation is not an art, distinct in itself, but is, or should be, one part or step in plant-breeding processes. In the case of fanciers' plants it is of less importance than in fruits, for a few plants satisfy the demand. Taken in a large sense it is immaterial whether the variation is originated by means of hybridisation or otherwise. The variety is its own justification. In the varieties produced by the private plant-breeders the public must be content to judge by the results, for the data of their origin are not often given. Hybridisation seems to be a magic word, and many of the new varieties which are attributed to it in this country are only seedlings of ordinary parentage. The laws of plant-breeding are to be worked out in the United States by the officers of the experiment stations. For the moment most of these workers are engrossed in the details of the business. Only two or three philosophical essays have appeared; but perhaps this is a sufficiently high proportion.

The foregoing review of experience suggests the tendencies in American plant-breeding efforts. The controlling tendency is to develop plants which are adapted to our native conditions; secondarily is the tendency to develop varieties to satisfy individual or personal desires. It is to be expected that as the general or national demands are satisfied the specific and personal demands will come to be more prominent. More and more, as years go by, will the European-bred varieties be used as bases for further breeding, rather than as perfected commodities in themselves. From time to time a race will come to be so distinctly developed in America that the European stock will no longer be needed. This has already occurred in the Carnation and the Chrysanthemum. Yet I hope and expect that the time will never come when the American loses interest in any novelty which the European brotherhood may produce. We must continue to draw, not only hybrids, but knowledge of hybridism from European sources.

There is a decided tendency to utilise our native species in the

development of ornamental plants, as we have in the development of fruits. Nearly 3,000 native species are now in cultivation as ornamental subjects. Already there is amalgamation of types, but it is evident that the process has only begun. It is possible that we may be able some day to offer the European gardener something of interest.

The greatest work of the hybridist is the development of tendencies and races rather than varieties. The slow and repeated amalgamation or blending of types is the consummation of plant-breeding. The production of a single hybrid which may be named and sold brings more present glory, but it is only an isolated fact. The best results come when species have been so completely blended that we cannot say which are hybrids and which are not.

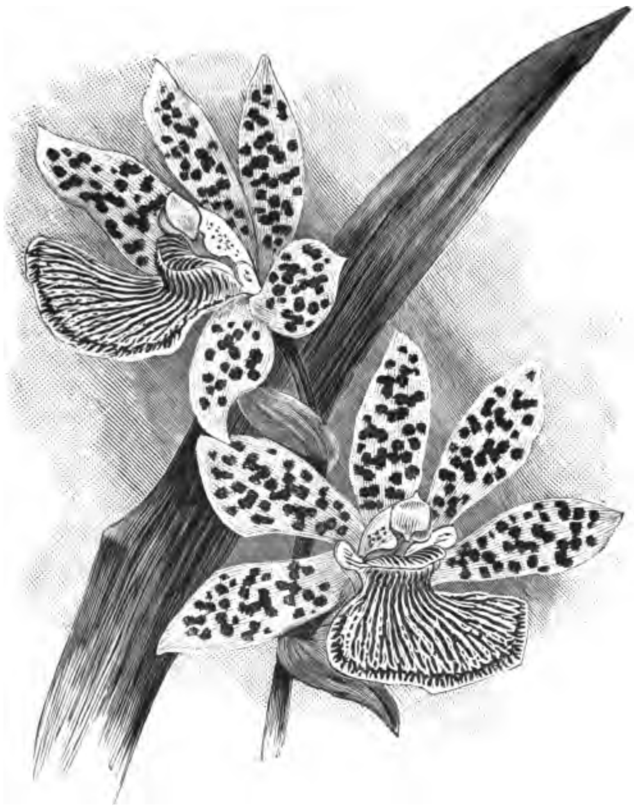


FIG. 103.—ZYGOCOLAX VEITCHI. (*Journal of Horticulture.*)
(COLOX JUGOSUS × ZYGOPETALUM MACKAYI CRINITUM.)

ON SELF-STERILITY.

By Professor Dr. F. Ludwig, the University of Greiz, Germany.

For years I have devoted particular attention to those plants which are sterile when pollinated with their own pollen, and have discovered that self-sterility is far more prevalent in the plant kingdom than has hitherto been imagined; that this, and not an entire loss of sexuality, is the cause that many species of plants in extensive districts or on an entire continent never, or scarcely ever, form seed; and, finally, that within the same species self-sterile individuals may be found in one place and self-fertile ones in another. Some of my observations and experiences are as follows.

Self-sterility I have found to occur with special regularity in the case of such plants as propagate themselves vigorously by means of rhizomes, offsets, or bulbils. The numerous plants which, in the course of years, I have raised from one individual—in the case of *Symphytum bulbosum, Dentaria bulbifera, Apocynum hypericifolium, A. androsæmifolium, Cypripedium Calceolus*, &c.—never set seed in my garden, despite the presence of their proper pollen-carrying insects, and despite artificial transference of the pollen from bloom to bloom. When, however, in the case of *Apocynum hypericifolium* and *A. androsæmifolium*, I brought plants into the garden from another source, the seed ripened. It is known also that *Dielytra spectabilis, Lysimachia nummularis*, and other plants are mostly propagated asexually, and then remain infertile. With *Ficaria verna*, which Schulz found to be gynomonœcious, and Delpino gynodiœcious with smaller female flowers (gynodimorphic),* and especially from the results obtained by Herm. Müller, who raised normal seed capable of germination from a bulbil-bearing plant, there can scarcely remain a doubt that the infertility springs from self-sterility, and that this can be removed if pollen from a foreign, that is, a physiologically independent, individual be applied. The individuals which are found to occupy one habitat probably spring, as a rule, from one and the same physiological individual being propagated through the free multiplication of the plant by epigœous and hypogœous bulbils. Delpino counted on one plant fifty-four hypogœous and twelve epigœous, and on another of the female form 124 hypogœous and seven epigœus bulbils. The same may be said of our European *Acorus Calamus*, the examples of which, throughout extensive districts, only represent one and the same physiological individual, owing to their exclusive propagation by the rhizome. Seeds have not been observed in Europe so far, as the plant is self-sterile; in America, however, the seed ripens not infrequently, and I am firmly convinced that by planting American plants in our waters the European Calamus would have its fertility restored. Some five years ago I planted the American Calamus in a pond near Greiz: it has spread

* "Dimorfismo del Ranunculus Ficaria. Memoria letta alla R. Accademia delle Scienze dell' Istituto di Bologna nella Sessione dell' 11 Aprile 1897."

vigorously, but so far, unfortunately, has not flowered. It is to be hoped that by its aid I shall succeed in rendering the European race a fertile one.

How far the signification of the self-sterile physiological individual should be carried, I learn from a letter of my late friend Dr. Fritz Müller, at Blumenau, in Brazil, dated January 24, 1895, referring to my communication regarding the planting of the American Calamus. For some years a beautiful Amaryllis, which is plentiful in the gardens about Blumenau, and which morphologically constitutes the offspring by bulb propagation from a single imported individual, has been observed to be entirely sterile. In 1884 Fritz Müller found the species growing wild near the sea, and crossed with individuals from this source, the garden form became fertile. A still more striking example of self-sterility is seen in *Hedychium coccineum.* The morphological individuals of the species are quite sterile between themselves, although the pollen is normally developed, and the species, united either as male or female, forms hybrids with kindred species of the same genus. Some years since Fritz Müller received *Hedychium coccineum* from Buitenzorg, among other Zingiberaceæ, and crossed numerous flowers of the plants—which had certainly been introduced into Brazil more than a century before—with these Javanese individuals, but without any results. He concludes, therefore, "that the individuals raised both in Brazil and in Java as decorative plants came from one and the same garden, into which a wild plant had originally been introduced."

I am much encouraged in the hope that I may restore fertility to the European Calamus by the following, in many respects, instructive attempt with *Trientalis europæa.*

I am acquainted with three quite isolated stations of this plant in the woods round Greiz, isolated but very extended, and far from any others. These, together with other relics, may have existed (according to Aug. Schulz) since the fourth of the Ice periods which are to be distinguished in Thuringia.* In any case, these stations have been occupied from time immemorial; and it appears, moreover, that at the present stations all the plants spring from the same rhizome, and have only propagated themselves by means of the rhizome because they are self-sterile, and for more than twenty years I have sought in vain to find a single seed capsule. At a distance of about four geographical miles Trientalis is found in quantity, and I brought examples from Struth at Niederpöllnitz in 1895 for observation in my garden, where they were fertile both with their own and with foreign pollen. In 1895 I planted four, and on March 29, 1897, some more examples from Struth among the self-sterile form in the Krümmthal, near Greiz, where annually thousands of self-sterile examples flower, and marked the places. The result was as expected. Even in 1895 I found not only on the introduced plants, but also on several of the old indigenous form, well-developed seed capsules, which also came to maturity. In 1898 I found about fifty ripe seed-vessels. The rejuvenescence of the race, self-sterile for ages, had thus been successfully effected; and the Calamus must, I think, also succeed.

* "Grundzüge einer Entwickelungsgeschichte der Pflanzenwelt Mitteleuropas seit Ausgang der Tertiarzeit," Iena, G. Fischer, 1894.

If, on the one hand, self-sterility is specially emphasised where extraordinarily vigorous asexual reproduction narrows down the likelihood of separate physiological individuals appearing, as in the case of *Symphytum bulbosum*, which, by offsets and their distribution, overran the whole of my garden in a few years; on the other hand, it particularly occurs, or even arises anew, where, with perennial plants, the prospects of cross-pollination seem specially secure.

Examples of this are seen in *Erodium macradenum*, *E. pimpinellifolium*, and others. Of the first, I had in my garden two very floriferous plants raised from seed, which were fully adapted for cross-pollination by insects * and bore seed. In 1881 one of these, being planted out earlier, flowered several weeks before the other. The numerous umbels which were developed at this time did not set a single seed, despite self and general pollination; whilst after the flowering of the other plants numerous flowers were xenogamously fertilised. When later one of the plants died, the other, it is true, flowered annually, and developed an extraordinary floriferousness (*anthomania*), but never produced another seed.

Erodium cicutarium is self-fertile. The insect-flowering form of *E. pimpinellifolium*, with large flowers and distinct "path-finder," presents, on the other hand, all stages to self-sterility, parallel with the perfection of arrangements for xenogamy.

More or less regular and effectual insect visits to the various stations appear also to be the cause of a self-sterile form being coexistent with a self-fertile one in the case of *Daphne mezereum*. For years I have had a self-sterile bush of this in my garden, which came from a station at which bees, *Colias Rhamni*, and other insects were plentiful. So long as a second example of different origin grew in the vicinity, both bore and ripened annually numerous berries. In 1889 the companion plant died, and since then not a single fruit have I obtained, notwithstanding that microscopically the pollen is seen to be unaltered, and natural and artificial pollination occurred among the flowers of the same stock. Twice, with years intervening, have I brought fresh blooming branches of Daphne from the wood into the vicinity, so that the numerous insects might carry foreign pollen to the plant. The result was what I expected. The self-sterile example of Daphne set its berries, and developed them further until I removed them. In the years intervening, and afterwards, the tree remained perfectly barren until its death. Schulz found in Thuringia *Daphne mezereum* self-fertile, and I myself have now a self-fertile plant in cultivation obtained from stations where insects are absent or scarce. It appears to me that an example of a step towards self-sterility is seen in a plant of *Helleborus fœtidus* obtained from Vernayaz, near St. Maurice, and possessing effective flowering arrangements. The two fruits, however, form no seed capable of germination; whilst examples less well adapted for insect fertilisation, from the Rhone Alps in Germany, form perfect seed. I have also in this case, for the continuance of the species, planted examples of both origins amongst each other.

In conclusion, we may summarise the opinions at which we have arrived in a few short sentences.

* See my work, "Kosmos IV.," Heft 11, *Bot. Centralblatt*, 1881, vol. v. p. 298.

1. It has so far been in no case demonstrated that plants of vigorous vegetative reproduction have entirely lost their capacity for sexual propagation.

2. On the other hand, such plants can apparently lose throughout entire districts the capacity for forming seeds capable of germination, when the flowering individuals are of the same vegetative origin. In fact, however, they are only self-sterile in the wider sense, and fertilisation can at any time be again effected by rendering possible foreign pollination by physiologically separate individuals.

3. Among perennial plants, which do not propagate themselves by rhizomes, bulbils, or other asexual means, self-sterility very often occurs with species in which cross-fertilisation appears to be secured.

4. With plants of asexual propagation it appears to increase with the predominance of the asexual reproduction.

5. In the last two cases named, with viviparous, bulbiferous, &c. species, and with perennial plants which do not propagate asexually, there may arise races, within the same species, which are self-sterile and self-fertile.

6. By introducing new plant species into our gardens, it is therefore always to be recommended, even when the species are hermaphrodite, homostylic, homogamic, &c., to obtain of each species at least two examples of as different origin as possible, or to introduce the seed from such.

CROSSINGS MADE AT THE NATURAL HISTORY MUSEUM OF PARIS FROM 1887 TO 1899.

By MONSIEUR L. HENRY,

Inspector of Open Air Cultivation at the Muséum, Professor at the National School of Horticulture of Versailles.

AT the end of April 1894, Professor Maxime Cornu, who had occupied for two months the Chair of Culture at the Museum, confided to me the post of Director of Open Air Cultures in this establishment.

I left Nancy where, as Superintendent of Practical Horticulture in the Mathieu de Dombasle School of Agriculture, and Professor of Horticulture in the the same school, I was witness of the very remarkable results obtained by hybridisation by Monsieur V. Lemoine, and had planned some experiments of the same nature myself.

My nomination to the Muséum was favourable to the realisation of this project. Nevertheless it could not be carried out for several years. Before I could find the leisure for it, it was necessary for me to master the details of the very complicated work of the Muséum, at once difficult and absorbing, and which, in addition, was being reorganised.

My first personal attempts date from 1887; previously, however, I had made sundry experiments according to the suggestions and often in the company of Professor Maxime Cornu, whose advice, as kindly as it was enlightened, was very valuable to me. At this period M. Cornu succeeded with several very interesting crosses, notably in the genus *Papaver* and the genus *Cucurbita.*

He had discovered, in a secluded corner of the garden, a very old and very strong specimen of the old double Lilac, *Syringa vulgaris*, var. *azurea plena*, a variety which, though we did not know it at the time, had served M. Lemoine for the raising of his first double Lilacs. Professor Cornu had guessed also what *rôle* this old type was capable of playing; he submitted it to crossing, and he was good enough to associate me with him in these trials. Half-a-dozen capsules were obtained in 1884. But preoccupations of an altogether different nature, and very pressing, caused us to lose sight of these capsules at the moment when they should have been gathered.

The duties and obligations of his post thenceforth did not permit the Professor, to his great regret, to occupy himself directly with these crossings. He was good enough to leave the arrangement to me, while guiding and encouraging me, for which my gratitude is profound.

Many attempts were made during ten years, very often followed by failure, very rarely by success. They are accurately recorded here in the hope that this report may be of some utility.

Without wishing at the present time to draw conclusions from the series of trials, I will only draw attention to the results of our crossing with Lilacs, themselves derived from hybridisation, but having preserved

the power of fructification. These crossings, which may be called crossings of the second degree, have generally succeeded much better than those made direct between specific types, that is to say, than the crossings of the first degree (see Nos. 7 to 12).

I may be permitted to express a regret—it is that in many cases the result of our trials has been compromised by accidental causes (excessive drought in 1893 and in the autumn of 1895; cyclone with hail at the end of July, 1896), and also and especially by indiscreet curiosity and sometimes by the wilful destruction of visitors (the Jardin des Plantes is open to the public), and even of certain of our gardeners.

Suggestions.

It would be interesting, we think, if it were only from the historical point of view, to endeavour to reconstitute certain plants which are currently considered as hybrids, but without certain proof of such origin. It would be a question of establishing this origin in a precise and indisputable manner, that is to say, to do for these plants that which M. Lemoine, of Nancy, and I have done for the Varin Lilac (*Syringa dubia*) in reconstituting it by means of crossings of the Persian Lilac with the common Lilac (see No. 23).

The Conference could perhaps organise a series of researches in this direction. I make the suggestion with that object.

By way of indication I give the following list, necessarily incomplete, of the plants I have in view. This short list comprises mainly woody species, with which I occupy myself more particularly.

List of Plants considered to be Hybrids, which it would be interesting to reconstitute by Crossing.

Amygdalus persicoides (Duham.)
=A. Persico-Amygdala (Daléch.).
Æsculus rubicunda (D.C.).
Berberis Neuberti (Hort.)
=B. ilicifolia (Hort.).
Berberis stenophylla (Moore).
Cerasus Fontanesiana (Spach)
=Prunus græca (Desf.).
Cratægus Oxyacantho-germanica (Gillot)
=C. grandiflora (K. Koch)
=C. lobata (Bosc.)
=Mespilus Smithii (D.C.).
Cytisus Adami (Poit.).
Dianthus semperflorens (Hort.).
Juglans hybrida (Hort.)
=Juglans pyriformis (Carr.).
Juglans Vilmoriniana (Carr.).
Prunus cerasifolia (Hort.)
=Padus græca (Desf.).
Pyrus malifolia (Spach).
Pyrus Bollwylleriana (D.C.).
Ribes Gordonianum (Lem.).
Ribes intermedium (Billiard 1867).
Robinia Decaisneana (Carr.).
Rosa alba (L.).
Rosa Fortuneana (Lindl.).
Rosa Hardyi (Cels).
Rosa hybrida (Schleich).
Rosa Noisettiana (Red.).
Rubus nobilis (Rgl.).
Sorbus hybrida (L.).
Spiræa Van Houttei (Briot).
&c., &c.

REPORT OF CROSSINGS MADE AT THE MUSEUM OF PARIS FROM 1887 TO 1899.

ORDER FOLLOWED.

	Nos.
Woody plants × Woody plants	1 to 77
Woody plants × Herbaceous plants and inversely	78 to 83
Herbaceous plants × Herbaceous plants	84 to 100

ALPHABETICAL TABLE.

Where the name is followed by a * the crossings have yielded plants.

Where the name is followed by two ** the crossings have not yet yielded plants, but yielded fruit in 1899, or bore fruit in 1898 from which the seed has not yet germinated.

Those followed by three *** are those which have yielded sterile seeds, or which for any other cause give no hope of germination.

	No.
Androsace sarmentosa (Wall.) × Primula veris (L.)	84
Clematis (hybrids with large flowers) × Clematis Davidiana (Verlot)	78
,, viticella (L.) × Clematis Davidiana (Verlot)	79
Cratægus Carrierei (Vauvel) × Cratægus monogyna (Jacq.), var. flore roseo (Hort.)	53
,, cuneata (Sieb. & Zucc.) × Cratægus monogyna (Jacq.), var. flore roseo (Hort.)**	54
,, flava (Hort.) × Cratægus monogyna (Jacq.), var. flore roseo (Hort.)**	58
,, lobata serotina (Carr.) × Cratægus monogyna (Jacq.), var. flore roseo (Hort.)**	55
,, monogyna (Jacq.), var. flore roseo × Cratægus Oxyacantho-germanica (Gillot)**	56
,, Oxyacantho-germanica (Gillot) × Cratægus monogyna (Jacq.), var. flore roseo (Hort.)	57
Datura meteloides (D.C.) × Nicotiana Tabacum (L.)	93
Deutzia discolor (Hemsl.), var. purpurascens (Franch.) × Deutzia crenata (Sieb. & Zucc.)**	60
,, discolor (Hemsl.), var. purpurascens (Franch.) × Deutzia gracilis (Sieb. & Zucc.)*	61
,, discolor (Hemsl.), var. purpurascens (Franch.) × Deutzia parviflora (Bnge.)	62
Diervilla canadensis (Willd.) × Diervilla rosea (Walp.)**	63
,, rosea (Walp.) × Diervilla canadensis (Willd.)**	64
Hypericum patulum (Thunb.) × Hypericum calycinum (L.)*	80
Iris acoroides (Spach) × Iris germanica (L.) and varieties	85
,, Delavayi (Franch.) × Iris aurea (Link)	88
,, pseudacorus (L.) × Iris Delavayi (Franch.)**	87
,, ,, ,, × Iris germanica (L.) and varieties**	86
Ligustrina japonica (Maxim.) × Chionanthus virginica (L.)	28
,, ,, ,, × Syringa Bretschneideri (Hort.)	27
,, ,, ,, × Syringa Emodi (Wall.)	26

	No.
Ligustrina japonica (Maxim.) × Syringa pubescens (Turcz.)	25
,, ,, ,, × Syringa vulgaris (L.)	24
,, pekinensis (Regel) × Ligustrum Ibota (Sieb.)	33
,, ,, ,, × Ligustrum nepalense (Wall.)	32
,, ,, ,, × Syringa Bretschneideri (Hort.)	31
,, ,, ,, × Syringa Emodi (Wall.)	30
,, ,, ,, × Syringa vulgaris (L.)**	29
Ligustrum Ibota (Sieb.) × Ligustrina pekinensis (Regel)**	34
,, ,, ,, × Ligustrum nepalense (Wall.)	35
,, ,, ,, × Syringa Bretschneideri (Hort.)	36
,, ,, ,, × Syringa persica (L.)	37
,, ,, ,, × Syringa pubescens (Turcz.)	38
,, ,, ,, × Syringa vulgaris (L.)	39
,, insulare (Dcne.) × Syringa dubia (Pers.)	40
,, ovalifolium (Hassk.) × Ligustrina japonica (Maxim.)	41
,, ,, ,, × Syringa dubia (Pers.)	42
,, ,, ,, × Syringa Josikæa (Jacq.)	43
,, ,, ,, × Syringa vulgaris (L.)	44
,, sinense (Lour.) × Ligustrina amurensis (Rupr.)	45
,, ,, ,, × Ligustrina japonica (Maxim.)	46
,, ,, ,, × Ligustrina pekinensis (Regel)	47
,, ,, ,, × Ligustrum Ibota (Sieb.)	49
,, ,, ,, × Ligustrum ovalifolium (Hassk.)	48
,, ,, ,, × Syringa Bretschneideri (Hort.)	50
,, ,, ,, × Syringa Emodi (Wall.)	51
,, ,, ,, × Syringa vulgaris (L.)	52
Lonicera Morrowi (A. Gray) × Lonicera sempervirens (Ait.)	65
,, sempervirens (Ait.) × Lonicera translucens (Carr.)	74
,, iberica (Bieb.) × Lonicera flava (Sims).	66
,, ,, ,, × Lonicera sempervirens (Ait.)	67
,, ,, ,, × Lonicera Caprifolium (L.)	68
,, involucrata (Banks) × Lonicera Caprifolium (L.)	69
,, translucens (Carr.) × Lonicera Caprifolium (L.)	71
,, ,, ,, × Lonicera flava (Sims)	72
,, ,, ,, × Lonicera glauca (Hill)	73
,, ,, ,, × Lonicera sempervirens (Ait.)	70
Nicotiana affinis (Hort.) × Nicotiana Tabacum (L.)***	90
,, Tabacum (L.) × Datura meteloides (D.C.)***	91
,, ,, × Nicotiana affinis (Hort.)***	89
,, ,, × Petunia nyctaginiflora (Juss.)***	92
Pæonia albiflora (Pall.) × Pæonia lutea (Franch.)**	81
,, lutea (Franch.) × Pæonia albiflora (Pall.)**	82
Potentilla fruticosa (Lour.) × Potentilla atrosanguinea (Don)	83
Rhodotypos kerrioides (Sieb. & Zucc.) × Kerria japonica (D.C.)	59
Sarothamnus scoparius (Koch) × Cytisus Laburnum (L.)	76
,, ,, ,, × Cytisus purpureus (Scop.)	75
Syringa Bretschneideri (Hort.) × Ligustrina pekinensis (Regel.)***	6
,, ,, ,, × Syringa Josikæa (Jacq.)*	1
,, ,, ,, × Syringa persica (L.)*	4

see the ...

= S. pekinensis

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	No.
Syringa Bretschneideri (Hort.) × Syringa pubescens (Turcz.) . .	5
„ „ „ × Syringa vulgaris (L.)*	3a
„ „ „ × Syringa vulgaris (L.), var. flore pleno (Hort.)*** . . .	3b
„ Bretschneideri × Josikæa (hyb.) × Ligustrina pekinensis (Regel.)**	7
„ Bretschneideri × Josikæa (hyb.) × Syringa Josikæa (Jacq.)*	8
„ „ „ „ × Syringa vulgaris (L.)* .	9a
„ „ „ „ × Syringa vulgaris (L.), var. fl. pleno (Hort.)* . .	9b
„ Bretschneideri × persica (hyb.) × Syringa persica (L.)** .	10
„ Bretschneideri × vulgaris (hyb.) × Syringa vulgaris (L.)** .	11a
„ „ „ „ × Syringa vulgaris (L.), flore pleno (Hort.)** . .	11b
„ „ „ „ × Syringa pubescens (Turcz.)** . . .	12
„ dubia (Pers.) × Syringa pubescens (Turcz.) . . .	13
„ Emodi (Wall.) × Ligustrina pekinensis (Regel)** . .	14
„ Josikæa (Jacq.) × Syringa Bretschneideri (Hort.)* . .	2
„ persica (L.) × Ligustrina pekinensis (Regel)*** . . .	15
„ „ × Syringa pubescens (Turcz.)	16
„ „ × Syringa vulgaris (L.) var.*	17
„ pubescens (Turcz.) × Syringa oblata (Lindl.) . . .	18
„ „ „ × Syringa persica (L.)	19
„ „ „ × Syringa vulgaris (L.)	20
„ vulgaris (L.) × Syringa Bretschneideri (Hort.)* . .	22
„ „ × Syringa persica (L.)*	23
„ „ × Syringa pubescens (Turcz.)**	21
Thalictrum Delavayi (Franch.) × Thalictrum medium (Jacq.) . .	94
„ medium (Jacq.) × Thalictrum Delavayi (Franch.)* .	95
Tulipa Gesneriana (L.) × Tulipa Greigii (Regel)***	96
„ Greigii (Regel) × Tulipa Gesneriana (L.)***	97
„ Greigii (Regel) × Tulipa sylvestris (L.)***	100
„ suaveolens (Roth.) × Tulipa Greigii (Regel)	98
„ sylvestris (L.) × Tulipa Greigii (Regel)***	99
Vitis Coignetiæ (Pull. & Planch.) × Vitis amurensis (Rupr.)* . .	77

SYRINGA.

The genus *Syringa* contains but a small number of species, but two of these species (*Syringa vulgaris* and *S. persica*) are—the first especially—very rich in varieties of the greatest beauty. On the other hand, the remaining species have as yet afforded very few varieties, and these generally not very marked ones. Thus, I think, there remains much to be done in this direction.

The beautiful Bretschneider Lilac, the natural seeds of which had hitherto yielded only flowers uniformly pink—a pink more or less pale or more or less flesh colour—appeared to me particularly susceptible of improvement as regards colour, form, and size of the inflorescence. The

Muséum had introduced it from China into France in 1880, and it first flowered in 1886. It was natural, therefore, that this establishment should occupy itself first with this species. It will be seen that our attempts in this direction were not without result.

The same with *Syringa pubescens*, introduced by us at the same time and from the same source (first flowering in 1885). Here our efforts, without being absolutely without result, have not had so much success.

The *Ligustrina*, all uniformly white, would certainly gain in interest if we could succeed in giving them other colours; but the numerous attempts which we have made to this end have so far completely failed. This, however, will not prevent us from persevering.

The origin of the Varin Lilac and other Lilacs of the same group (*Syringa dubia*) has remained for a long time uncertain. Some botanists considered the Varin Lilac to be a species introduced from China, others that it was a hybrid between *Syringa vulgaris* and *S. persica.* A careful examination of the shrub caused me to adopt this latter opinion. It appeared to me interesting to reconstitute this Lilac by crossing the Persian Lilac with the common Lilac. There resulted three plants which presented absolutely the characters of *Syringa dubia.* Unfortunately these plants died before flowering. But at the same time whilst I was working, and without any concerted co-operation, M. Lemoine, of Nancy, pursued the same course in order to obtain a double-flowered Varin Lilac. More fortunate than I was, he succeeded in flowering his seedling in 1887. The hybrid origin of the Varin Lilac was thus confirmed (see page 299).

If Lilacs have been obtained in a certain way, hitherto by crossing *Syringa persica* with *Syringa vulgaris*, it does not appear that anyone has ever attempted to obtain an inverse cross. This I have now done, and I possess to-day a series of young plants thus obtained. They are vigorous, and afford us good hope.

1. **Syringa Bretschneideri** (Hort.); *syn.* S. *Emodi rosea* (Max. Cornu), *S. villosa* (Sarg. not Vahl.). Crossed with **Syringa Josikæa** (Jacq.).

Object.—To obtain deeper colours.

This crossing I began on May 20, 1890, and have repeated for several years upon a certain number of inflorescences with variable results.

Fertilisations of 1890—231 plants obtained.

The flowering commenced with two plants in 1896, and since then some fifty have flowered.

Fertilisations of 1894—35 plants, which began to flower in 1899.

Characters of the Lilacs produced by this cross:

Habit closely resembles that of *S. Bretschneideri.*

Leaves smaller and less firm than on this latter, larger than on *S. Josikæa*, bearing hairs upon the under side, as in *S. Bretschneideri* (in *S. Josikæa* the leaves are glabrous).

Inflorescence in form the same as in *S. Bretschneideri*: that is to say, much longer and more branched than in *S. Josikæa*, and moreover fuller and better furnished, pyramidal and in open panicles, rachis and petiole tinted violet and plum colour as in *S. Josikæa.*

Flowers much resemble those of *S. Josikæa*:

1. In colour, being violet, violet-tinted, bluish or reddish, instead of being pink or pinkish-white, as in the Bretschneider Lilac.
2. By their slenderer dimensions than in the Bretschneider Lilac.

Fig. 104.—A—Syringa Josikæa (Jacq.) ♂. C—Syringa Bretscneideri (Hort.) = S. Emodi rosea, Max. Cornu ♀. B—Syringa Bretschneideri × S. Josikæa.

3. By their form being that of a trumpet instead of a funnel; nevertheless the divisions are larger, more rounded, less incurved than in *S. Josikæa*, and they finish by turning outward like the Bretschneider Lilac. (Fig. 104.)

The object sought for (change of colour of the flower) has therefore been obtained in as satisfactory a manner as possible, whilst preserving the habit of growth of the Bretschneider Lilac.

2. **Syringa Josikæa** (Jacq.) × **S. Bretschneideri** (Hort.).

From crosses made in 1890 I have obtained thirty-two plants, which have commenced to flower in 1897.

The result has turned out fairly the same as in the inverse cross (see above). In comparing, however, the two results it may be noted that in this cross:—The leaves are longer, with more attenuated points, and less hairy, sometimes altogether glabrous. The inflorescences are narrower and a little less furnished; the rachis is of darker colour. The buds are redder, and the divisions of the flowers wider open and more recurved. The flowers also present more red, and some of the plants have them of a very striking purplish colour.

To sum up, in the two cases, the influence of the parents may be thus specified:—*S. Bretschneideri* shows itself particularly in the habit of growth, the stems, the leaves, and the shape of the inflorescence. The influence of *S. Josikæa* is seen most in the shape of flower, its colour, form, and dimensions.

3. **Syringa Bretschneideri** (Hort.) × **Syringa vulgaris** (L.).

Object.—To obtain new colours in the Bretschneider Lilac, an agreeable scent, and an earlier flowering. (The Bretschneider Lilac is pink, has a smell resembling that of Privet, and flowers twelve days later than the Common Lilac.) Numerous and repeated attempts were made, at first taking pollen from single-flowered varieties, and then from double-flowered ones.

(*a*) *Crosses with single-flowered varieties.*

1890. Eleven inflorescences treated. Five gave seed, none germinated.

1893. Five inflorescences treated. Two yielded seed, which gave one plant.

1894. Four inflorescences treated. Two yielded seed, which gave ten plants. One of these plants flowered in 1899 a lovely pink. (The variety which furnished the pollen used to obtain this plant is the Lilac 'Charles X.')

1895. Three inflorescences treated. One yielded seed, which gave two plants.

1896. Five inflorescences treated. One seed gathered, gave one plant.

1897. Three inflorescences treated. Two yielded seed, which gave fourteen plants.

1899. One inflorescence treated. Two fruits appeared to be good on July 4, 1899.

(*b*) *Crosses with double-flowered varieties.*

1894. One inflorescence treated. Four seeds obtained, not germinated.

1896. Two inflorescences treated. One gave seed, which did not germinate.

1897. One inflorescence treated. Gave seed, which did not germinate.

1898. One inflorescence treated. No result.

4. Syringa Bretschneideri (Hort.) × S. persica (L.).

Object.—The same as with *S. vulgaris*.

1895. One inflorescence crossed. One seed gathered, which gave a plant, which in 1899 has flowered in a very peculiar manner. Colour pink. Inflorescence arranged in fives at the extremities of the stalks. Flowers rather slender.

5. Syringa Bretschneideri (Hort.) × S. pubescens (Turcz.).

Object.—To obtain earlier flowers, and an agreeable scent.

1898. One inflorescence treated. Result nil.

6. Syringa Bretschneideri (Hort.) × Ligustrina pekinensis (Regel).

1895. Six inflorescences treated. Some seeds obtained, but they have not germinated.

7. Syringa Bretschneideri × Josikæa (hybrid) × Ligustrina pekinensis (Regel).

Cross of second degree.

1899. Two inflorescences treated. Seventy-two fruits swollen, and so far promising to perfect.

8. Syringa Bretschneideri × Josikæa (hybrid) × S. Josikæa (Jacq.).

Cross of second degree.

1898. A score of seeds obtained. Two small plants now appearing.

9. Syringa Bretschneideri × Josikæa (hybrid) × Syringa vulgaris (L.).

Cross of second degree.

(*a*) *Crossed with single-flowered varieties.*

1898. Seven inflorescences treated. One yielded seed, which gave nine plants.

1899. One inflorescence treated. Three fruits now swollen, and promising to perfect.

(*b*) *Crossed with double-flowered varieties.*

1898. Three inflorescences treated. Two yielded seed, which gave three plants.

1899. One inflorescence treated. Eight fruits swollen, and appearing good (July 4, 1899).

10. Syringa Bretschneideri × persica (hybrid) × **S. persica** (L.).

Cross of second degree.

Object.—To accentuate the influence of S. persica.

1899. One inflorescence treated. Five fruits swollen, and in good condition (July 4, 1899).

11. Syringa Bretschneideri × vulgaris (hybrid) × **S. vulgaris** (L.).

Cross of second degree.

(*a*) *Cross with single-flowered varieties.*

Object.—To accentuate the influence of *S. vulgaris.*

1899. Two inflorescences treated. Twelve fruits swollen and well formed (July 4, 1899).

(*b*) *Cross with double-flowered varieties.*

1899. Three inflorescences treated. Thirty fruits swollen, of which twenty-seven are well formed, and three smaller (July 4, 1899).

12. Syringa Bretschneideri × vulgaris (hybrid) × **S. pubescens** (Turcz.).

1899. Two inflorescences treated. Eighteen fruits swollen and well formed (July 4, 1899).

13. Syringa dubia (Pers.) × **S. pubescens** (Turcz.).

Object.—To obtain something special from *Syringa dubia,* which, contrary to what has been long believed, produces good seed sometimes.

1890. One inflorescence treated. Result nil.

14. Syringa Emodi (Wall.) × **Ligustrina pekinensis** (Regel).

Object.—Experiment with a *Ligustrina.*

1899. One inflorescence treated. Six fruits swollen. Result at present uncertain, fertilisation appearing to have operated too late.

15. Syringa persica (L.) × **Ligustrina pekinensis** (Regel).

Object.—To investigate *Ligustrina.*

1895. Three inflorescences treated. Some seeds gathered, none germinated.

16. Syringa persica (L.) × **S. pubescens** (Turcz.).

1890. Three inflorescences treated. Results nil.
1895. One inflorescence treated. Result nil.
1896. Two inflorescences treated. Results nil.
1897. One inflorescence treated. Result nil.
1899. Three inflorescences treated. Results nil.

17. Syringa persica (L.) × **S. vulgaris** (L.).

Object.—Reconstitution of *S. dubia* (Pers.), considered to be a hybrid by several botanists.

1894. Three inflorescences treated. Four seeds obtained, three germinated.

The plants present all the characters of *Syringa dubia.* Unfortunately one died at the end of some months, another perished in 1896, and the third in 1897.

1897. Three inflorescences treated. No results.

18. Syringa pubescens (Turcz.) × S. oblata (Lindl.).

1899. Two inflorescences treated. Results nil.

19. Syringa pubescens (Turcz.) × S. persica (L.).

Object.—To obtain a later flowering form of S. pubescens, which blooms very early, and hence is often damaged by frosts; and to vary its colour.

1890. Four inflorescences treated. Result nil.

1895. Six inflorescences treated. One of these set three fruits. The branch was broken by a workman, who pulled it down violently to see if the fertilisation were effected.

1896. Four inflorescences treated. Results nil.

1898. Three inflorescences treated. Result nil.

1899. Six inflorescences treated. Three fruits which had set subsequently dried off.

20. Syringa pubescens (Turcz.) × S. vulgaris (L.).

Object.—To vary the uniform lilac-bluish colour of *Syringa pubescens.*

1890. Four inflorescences treated. Result nil.

1895. Four inflorescences treated. Result nil.

1898. Five inflorescences treated. Result nil.

1899. Six inflorescences treated. Result nil.

21. Syringa vulgaris (L.) × S. pubescens (Turcz.).

Object.—To obtain new forms of *S. vulgaris.*

1890. Three inflorescences treated. Result nil.

1895. Two inflorescences treated. One gave several seeds, which did not germinate.

1896. Two inflorescences treated. One gave several seeds, which did not germinate.

1897. Two inflorescences treated. Result nil.

1898. Three inflorescences treated. Result nil.

1899. Five inflorescences treated. Two are bearing well-formed fruits, one four and the other twelve (July 4, 1899).

22. Syringa vulgaris (L.) × S. Bretschneideri (Hort.).

Object.—To obtain a later flowering *S. vulgaris.*

1890. Two inflorescences treated. Result nil.

1896. Two inflorescences treated. Result nil.

1897. Four inflorescences treated. All have given seed, but there only resulted two plants, which are at present in good condition.

1898. Two inflorescences treated. Some seeds obtained; not yet germinated.

23. Syringa vulgaris (L.) × **S. persica** (L.).

Object.—To obtain the counterpart of *Syringa dubia*, which results, as is known, from crossing *Syringa persica* × *S. vulgaris*.

1894. Two inflorescences treated. Result, two seeds, which have not germinated.

1895. Three inflorescences treated. One has given some seeds, which did not germinate.

1897. Four inflorescences treated. Two have yielded seed, which have furnished thirty-five plants, now in very good condition.

1898. Two inflorescences treated. Results nil.

1899. Two inflorescences treated. Thirty-two fruits set (July 4, 1899).

24. Ligustrina japonica (Maxim.) × **Syringa vulgaris** (L.).

Object.—To vary the colours of the uniformly white *Ligustrina*.

1896. Three inflorescences treated. Results nil.

1897. One inflorescence treated. Result nil.

25. Ligustrina japonica (Maxim.) × **Syringa pubescens** (Turcz.).

1899. One inflorescence treated. Result nil.

26. Ligustrina japonica (Maxim.) × **Syringa Emodi** (Wall.).

1897. One inflorescence treated. Result nil.

1899. Two inflorescences treated. Results nil.

27. Ligustrina japonica (Maxim.) × **Syringa Bretschneideri** (Hort.).

1897. One inflorescence treated. Result nil.

28. Ligustrina japonica (Maxim.) × **Chionanthus virginica** (L.).

1898. One inflorescence treated. Result nil.

1899. One inflorescence treated. Result nil.

29. Ligustrina pekinensis (Regel) × **Syringa vulgaris** (L.).

1899. Two inflorescences treated. Result, one fruit set, but success appears doubtful.

30. Ligustrina pekinensis (Regel) × **Syringa Emodi** (Wall.).

1899. One inflorescence treated. Result nil.

31. Ligustrina pekinensis (Regel) × **Syringa Bretschneideri** (Hort.).

1895. Three inflorescences treated. Result nil.

1898. Two inflorescences treated. Result nil.

1899. Two inflorescences treated. Result nil.

32. Ligustrina pekinensis (Regel) × **Ligustrum nepalense** (Wall.).

Object.—To see whether if crossed with the *Ligustrum*, the *Ligustrina* would give the results which failed to be obtained with the *Syringas*.

1895. One inflorescence treated. Result nil.

33. Ligustrina pekinensis (Regel) × **Ligustrum Ibota** (Sieb.).

1898. One inflorescence treated. Result nil.
1899. One inflorescence treated. Result nil.

34. Ligustrum Ibota (Sieb.) × **Ligustrina pekinensis** (Regel).

Object.—To obtain larger inflorescences on *Ligustrum.*
1895. Four inflorescences treated. Result nil.
1897. Four inflorescences treated. Result nil.
1898. Three inflorescences treated. Result nil.
1899. Three inflorescences treated. Thirteen fruits set, and appear as if they would succeed.

35. Ligustrum Ibota (Sieb.) × **Ligustrum nepalense** (Wall.).

Object.—To obtain larger inflorescences in *Ligustrum Ibota.*
1895. Two inflorescences treated. Result nil.

36. Ligustrum Ibota (Sieb.) × **Syringa Bretschneideri** (Hort.).

1897. Eight inflorescences treated. One fruit gathered has given a plant which has yet to be proved; it is not distinct enough to afford a certainty that a cross has really been effected.
1899. One inflorescence treated. Result nil.

37. Ligustrum Ibota (Sieb.) × **Syringa persica** (L.).

1897. One inflorescence treated. Result nil.

38. Ligustrum Ibota (Sieb.) × **Syringa pubescens** (Turcz.).

1898. One inflorescence treated. Result nil.

39. Ligustrum Ibota (Sieb.) × **Syringa vulgaris** (L.).

1897. Two inflorescences treated. Result nil.
1898. Two inflorescences treated. Result nil.
1899. Two inflorescences treated. Result nil.

40. Ligustrum insulare (Dcne.) × **Syringa dubia** (Pers.).

1897. Two inflorescences treated. Result nil.

41. Ligustrum ovalifolium (Hassk.) × **Ligustrina japonica** (Maxim.).

1897. Two inflorescences treated. Result nil. = S. amurensis

42. Ligustrum ovalifolium (Hassk.) × **Syringa dubia** (Pers.).

1897. Four inflorescences treated. Result nil.

43. Ligustrum ovalifolium (Hassk.) × **Syringa Josikæa** (Jacq.).

1897. One inflorescence treated. Result nil.

44. Ligustrum ovalifolium (Hassk.) × **Syringa vulgaris** (L.).

1897. Two inflorescences treated. Result nil.

45. Ligustrum sinense (Lour.) × **Ligustrina amurensis** (Rupr.).

1895. One inflorescence treated. Result nil. = S. amurensis

46. Ligustrum sinense (Lour.) × **Ligustrina japonica** (Maxim.).

1895. Two inflorescences treated. Result nil.
1897. Two inflorescences treated. Result nil.

47. Ligustrum sinense (Lour.) × **Ligustrina pekinensis** (Regel).

1897. Three inflorescences treated. Result nil. = S. pekinensis Rupr.

48. Ligustrum sinense (Lour.) × **L. ovalifolium** (Hassk.).

1895. Three inflorescences treated. Result nil.

49. Ligustrum sinense (Lour.) × **Ligustrum Ibota** (Sieb.).

1895. Two inflorescences treated. Result nil.

50. Ligustrum sinense (Lour.) × **Syringa Bretschneideri** (Hort.).

1895. One inflorescence treated. Result nil.

51. Ligustrum sinense (Lour.) × **Syringa Emodi** (Wall.).

1897. Two inflorescences treated. Result nil.

52. Ligustrum sinense (Lour.) × **Syringa vulgaris** (L.).

1897. Five inflorescences treated. Result nil.

53. Cratægus Carrierei (Vauvel) × **C. monogyna** (Jacq.), **var. flore roseo.**

Object.—To obtain a form of the beautiful *Cratægus Carrierei* with rose-coloured flower.

1889. Two inflorescences treated. Result nil.

54. Cratægus cuneata (Sieb. & Zucc.) × **C. monogyna** (Jacq.), **var. flore roseo.**

1898. Two inflorescences treated. Nine seeds obtained; sown September 30, 1898; not yet germinated.

1899. One inflorescence treated. One fruit well set (July 4, 1899).

55. Cratægus lobata serotina (Carr.) × **C. monogyna** (Jacq.), **var. flore roseo.**

Object.—To obtain rose-coloured or red flowers on *Cratægus lobata serotina* (Carr.), which is one of the finest known, having semi-persistent foliage, yellow pear-shaped fruits which remain upon the tree the greater part of the winter, and very numerous and comparatively very large flowers.

1898. Two inflorescences treated. Four seeds obtained, sown March 6, 1899; not yet visible (July 4, 1899).

1899. Two inflorescences treated. One fruit set (July 4, 1899).

56. Cratægus monogyna (Jacq.), **var. flore roseo** × **C. Oxyacantho-germanica** (Gillot)=C. grandiflora (K. Koch).

1898. One inflorescence treated. Obtained one fruit, sown September 21, 1898; not yet appeared (July 4, 1899).

57. Cratægus Oxyacantho-germanica (Gillot) × **C. mogogyna** (Jacq.), **var. flore roseo.**

Object.—To obtain rose-coloured flowers on *Cratægus Oxyacantho-germanica* (Gillot).

1898. Five flowers treated. Result nil.

58. Cratægus flava (Hort.) × **C. monogyna** (Jacq.), **var. flore roseo.**

1898. Two inflorescences treated. Obtained eleven seeds, sown December 26, 1898; not yet appeared (July 4, 1899).

59. Rhodotypos kerrioides (Sieb. & Zucc.) × **Kerria japonica** (D.C.).

1898. Ten flowers treated. Result nil.

60. Deutzia discolor (Hemsl.), **var purpurascens** (Franch.) × **Deutzia crenata** (Sieb. & Zucc.), var. flore pleno.

Object.—To double the flowers of *D. discolor purpurascens.*

1894. Three inflorescences treated. Result nil.

1899. Two inflorescences treated. One fruit set.

61. Deutzia discolor (Hemsl.), **var. purpurascens** (Franch.) × **D. gracilis** (Sieb. & Zucc.).

1894. Two inflorescences treated. One plant obtained, flowered in 1897. M. Lemoine, of Nancy, showed a similar cross at the quinquennial exhibition at Ghent, April 1898.

1896. Two inflorescences treated. Some few seeds gathered, have not germinated.

62. Deutzia discolor (Hemsl.), **var. purpurascens** (Franch.) × **Deutzia parviflora** (Bnge.).

1894. Two inflorescences treated. Result nil.

1896. Two inflorescences treated. Result nil.

63. Diervilla canadensis (Willd.) × **D. rosea** (Walp.).

Object.—To vary the hitherto uniformly pale yellow colours of *D. canadensis.*

1898. Five flowers treated. Fifty seeds sown September 30, 1898; not yet showing (July 4, 1899).

1899. Six flowers treated. Two fruits set (July 4, 1899).

64. Diervilla rosea (Walp.) × **D. canadensis** (Willd.).

Object.—To obtain new colours in *D. rosea.*

1898. Ten flowers treated. Fourteen seeds gathered, sown September 30, 1898; not yet showing (July 4, 1899).

1899. Twelve flowers treated. Eight fruits set (July 4, 1899).

65. Lonicera Morrowi (A. Gray) × **L. Sempervirens** (Ait.).

Object.—To obtain larger flowers on *L. Morrowi.*

1896. Three inflorescences treated. Result nil.

66. Lonicera iberica (Bieb.) × **L. flava** (Sims).

Object.—To obtain larger flowers on *L. iberica.*

1899. Eight flowers treated. Result nil.

67. Lonicera iberica (Bieb.) × **L. sempervirens** (Ait.).

1899. Eight flowers treated. Result nil.

68. Lonicera iberica (Bieb.) × **L. Caprifolium** (L.).

1899. Eight flowers treated. Result nil.

69. Lonicera involucrata (Banks) × **L. Caprifolium** (L.).

Object.—To obtain larger flowers on the beautiful *Lonicera involucrata.*

1899. Ten flowers treated. Result nil.

70. Lonicera translucens (Carr.) × **L. sempervirens** (Ait.).

Object.—To obtain larger flowers on *L. translucens*, already a very fine species.

1896. Four floral sprays treated. Result nil.
1898. Two floral sprays treated. Result nil.

71. Lonicera translucens (Carr.) × **L. Caprifolium** (L.).

1898. Three floral sprays treated. Result nil.
1899. Three floral sprays treated. Result nil.

72. Lonicera translucens (Carr.) × **L. flava** (Sims).

1898. Two floral sprays treated. Result nil.
1899. Two floral sprays treated. Result nil.

73. Lonicera translucens (Carr.) × **L. glauca** (Hill).

1898. Two floral sprays treated. Result nil.

74 Lonicera sempervirens (Ait.) × **L. translucens** (Carr.).

1896. Three floral sprays treated. Result nil.

75. Sarothamnus scoparius (Koch) × **Cytisus purpureus** (Scop.).

1898. Ten flowers treated. Result nil.

76. Sarothamnus scoparius (Koch) × **Cytisus Laburnum** (L.).

1898. Ten flowers treated. Result nil.

77. Vitis Coignetiæ (Pull. and Planch.) × **Vitis amurensis** (Rupr.).

Object.—To obtain fruits from *Vitis Coignetiæ*, of which so far only female plants have been observed to flower, while we only possess male plants of *Vitis amurensis.*

1896. Ten bunches treated. Result destroyed by hail.

1897. Ten bunches treated. Gathered five or six berries which have been preserved in alcohol.

1898. Ten bunches treated. Gathered forty seeds October 5, some December 27; all have come up well.

78. Clematis, var. grandiflora (Hort.) × **Clematis Davidiana** (Verlot).

Object.—To obtain Clematis with large sweet-smelling flowers (the flowers of David's Clematis are agreeably scented).

NOTE.—*Clematis Davidiana* is a herbaceous species.

1890. Eleven flowers treated, in five varieties. Result nil.

79. Clematis viticella (L.) × **C. Davidiana** (Verlot).

1890. Five flowers treated. Result nil.

80. Hypericum patulum (Thunb.) × **H. calycinum** (L.).

Object.—To obtain in *Hypericum patulum*, which is shrubby and upright, flowers as large as those of *Hypericum calycinum*, which is herbaceous and creeping.

1896. Four flowers treated. One capsule gathered, yielded no plants.

1897. Five flowers treated. Result nil.

1898. Five flowers treated. Some seeds gathered have given two plants; now vigorous.

81. Pæonia albiflora (Pall.) × **P. lutea** (Franch.).

Object.—To obtain, by the intervention of a very lovely lustrous yellow colour, new colours in the Chinese Pæonies (herbaceous).

NOTE.—*Pæonia lutea* is a new woody species introduced by the Muséum in 1886, from Yunnan.

1897. Five flowers treated. Result nil.

1899. Six flowers treated. One seemed to succeed. One carpel has swollen.

82. Pæonia lutea (Franch.) × **P. albiflora** (Pall.).

Object.—To vary the glossy yellow colour of *P. lutea*.

1899. Four flowers treated. Three appear to promise results; they show ten carpels swelling.

83. Potentilla fruticosa (Lour.) × **P. atrosanguinea** (Don).

Object.—To obtain other colours in *Potentilla fruticosa*, so far uniformly yellow.

NOTE.—*Potentilla atrosanguinea* is a herbaceous species.

1897. Seven flowers treated. Result nil.

84. Androsace sarmentosa (Wall.) × **Primula officinalis** (Jacq.) = P. veris (L.).

1897. Two inflorescences treated. One had set, and promised well; it was cut off and found on the spot (June 5, 1897).

85. Iris acoroides (Spach) × **I. germanica** (L.) and varieties.

Object.—To obtain for water culture Irises of large size and variously coloured flowers.

1896. Twelve flowers treated. Result nil.

1897. Ten flowers treated. Result nil.

1899. Ten flowers treated. Result nil.

86. Iris pseudacorus (L.) × **Iris germanica** (L.) and varieties.

Object.—To obtain for water culture Irises of varied colours, like the *Iris germanica.*

1896. Fifteen flowers treated. Five had set, but the fruits were destroyed by a malicious gardener.

1897. Fifty flowers treated. Nine fruits set, three have been destroyed by visitors, six have given seed, which when sown have only so far yielded yellow flowers, which leads to the supposition that the operation was badly done.

1899. Twenty-five flowers treated. Three fruits set (July 4, 1899).

87. Iris pseudacorus (L.) × **Iris Delavayi** (Franch.).

Object.—To vary the colours of *Iris pseudacorus. Iris Delavayi,* introduced by the Muséum in 1886, is an aquatic species with fine blue flowers. Habitat Yunnan.

1898. Five flowers treated. Result nil.

1899. Five flowers treated. One fruit set, looks good.

88. Iris Delavayi (Franch.) × **Iris aurea** (Link).

1899. Two flowers treated. One fruit set, but doubtful.

89. Nicotiana Tabacum (L.) × **Nicotiana affinis** (Hort.).

Object.—To obtain in *Nicotiana Tabacum* large scented flowers like those of *N. affinis.* The plant thus transformed would be probably very ornamental on account of its height and good habit.

From 1887 to 1898 attempts have been made each year without result, although we have several times obtained capsules. The seeds have never come up. Every year some ten to twenty flowers have been treated.

90. Nicotiana affinis (Hort.) × **Nicotiana Tabacum** (L.).

Object.—To vary the *Nicotiana affinis.*

From 1887 to 1898 numerous attempts, but no results. Some ovaries have swollen, but the seed was bad and has not come up.

91. Nicotiana Tabacum (L.) × **Datura meteloides** (D.C.).

1889. Ten flowers treated. Only one capsule gathered which contained seeds incompletely developed, and incapable of germinating. They have given no results.

92. Nicotiana Tabacum (L.) × **Petunia nyctaginiflora** (Juss.).

1889. Twenty flowers treated. Thirteen capsules gathered. Seed did not come up.

1890. Ten flowers treated. Results nil.

93. Datura meteloides (D.C.) × **Nicotiana Tabacum** (L.).

1889. Two flowers treated. Results nil.

94. Thalictrum Delavayi (Franch.) × **T. medium** (Jacq.).

Object.—To obtain taller plants, more vigorous and hardy than *T. Delavayi.*

Note.—*Thalictrum Delavayi* was introduced by the Muséum in 1886. It has fine blue flowers.

1897. Two inflorescences. Result nil.
1898. Three inflorescences. Result nil.

95. Thalictrum medium (Jacq.) × **T. Delavayi** (Franch.).

Object.—To obtain blue flowers on *Thalictrum medium,* which is a fine large plant, but with yellowish flowers.

1897. One inflorescence treated. One plant obtained. Seems as if it would flower very soon.

96. Tulipa Gesneriana (L.) × **T. Greigii** (Rgl.).

Object.—To obtain in *Tulipa Gesneriana* the beautiful form and rich colours of the flowers of *Tulipa Greigii.*

1894. Ten flowers treated. Two capsules obtained ; seed not come up.
1897. Thirteen flowers treated. Result nil.

97. Tulipa Greigii (Rgl.) × **T. Gesneriana** (L.) var.

1896. Five flowers treated. One capsule obtained; seeds not come up.
1897. Seven flowers treated. Result nil.
1898. Four flowers treated. Result nil.
1899. Four flowers treated. Result nil.

98. Tulipa suaveolens (Roth.) × **T. Greigii** (Rgl.).

1897. Two flowers treated. Result nil.

99. Tulipa sylvestris (L.) × **Tulipa Greigii** (Rgl.).

1894. Ten flowers treated. Two capsules obtained; seeds not come up.
1897. Ten flowers treated. Result nil.

100. Tulipa Greigii (Rgl.) × **Tulipa sylvestris** (L.).

Object.—To try to make *Tulipa Greigii* vary by means of a species which has the same creeping growth.

1894. Two flowers treated. One capsule obtained ; seeds not come up.

CAN HYBRIDS BE OBTAINED BY GRAFTING?

THE BRONVAUX MEDLAR.*

By Monsieur E. JOUIN.

To this question, so big with controversy, I reply affirmatively, and my opinion is supported by facts which I have verified. I will endeavour to set forth, as clearly as possible, the facts upon which I base my opinion.

Although discussed at various congresses, especially at Amsterdam in 1865, the theory that hybrids were obtainable by grafting has always evoked lively opposition. I am certain that after having seen the phenomenal 'Bronvaux Medlar,'† of which I am going to speak, many people, even those most opposed to this theory, will consent, if not to admit it in its entirety, at any rate to study it with an open mind.

The Medlar in question, more than a century old, is head-grafted on Whitethorn. It was pointed out to me about three years ago, by M. Dardar, a landowner at Bronvaux, near Metz, who had observed this tree for a long time. Immediately below the graft, the stock (Whitethorn) has sent out a branch (which we will call No. 1), intermediate between the Whitethorn and the Medlar (*Mespilus germanica*), being, however, nearer to this latter than to the Whitethorn.

This branch differs from the grafted parts of the tree, that is to say, the true Medlar, in that it is thorny and, instead of bearing solitary flowers, the blossoms are arranged in corymbs containing as many as twelve flowers. The fruits (Medlars) are small, and generally very much flattened.

Just at the side of this same branch, starting from the same point of insertion, there has been developed another entirely different (form No. 2), the young leaves of which are lobed, downy, and of the shape of those of the Whitethorn. The adult leaves, on the contrary, are hardly lobed or not at all, somewhat elongated, and in short have a certain resemblance to those of the Medlar. Young buds, pubescent; flowers in corymbs, nearly analogous to those of the Whitethorn, but a trifle larger, and with pubescent calyces. These flowers, two years ago, were rosy; sometimes too the rosy petals alternate with white ones. This year I have only remarked white flowers; it is true that I have only seen them towards the end of the flowering season, which possibly may explain this change of colour.

The fruits of this form, according to M. Dardar, are lengthened, brown, smaller, and completely different from the true Medlar.

The same tree has also produced, and also just below the graft, another very remarkable branch (form No. 3). The base of the said branch is simply Whitethorn, but the extremity has been transformed into a branch, which, if it be not analogous to form No. 2, is extremely near it.

* The account of this Medlar first appeared in *Le Jardin*, and was afterwards forwarded to the Conference.

† See *Report of the Horticultural Congress of Paris*, 1898, 9th question, "Of the Influence of the Graft upon the Stock, and the Stock on the Graft."

This third form, unhappily, only exists on the mother plant as a dead branch. It is possible that I have cut this branch a little too severely, in taking shoots for grafting. But, fortunately, the grafts have established themselves very well, so that I shall be able to study this form.

This year I have been able to establish two new phenomena not previously noticed. Form No. 1 has given birth to a young branch which is the true Medlar (flower solitary). On the same form a twig, bifurcated at a short distance from its point of insertion, has given, on one side a Whitethorn inflorescence, and on the other a corymb of eight Medlar flowers. It is probable that every year I shall be able to record new developments.

What should be concluded from this extraordinary disassociation? In my humble opinion all the changes are due, without a doubt, to the influence of the graft (Medlar) on the stock (Whitethorn). The intermediate forms which have issued therefrom, and which I possess as vigorous plants two years old, secured by grafting, cannot logically be otherwise designated than by the name of *Hybrids*, unless, indeed, a more special designation be adopted for crossbreeds obtained by grafting.

If the name of hybrid should be applied to them, it will be necessary in botanical treatises to rectify the definition of this name and set forth the different sorts of hybrids thus: (1) those arrived at through the seed, and (2) those obtained by grafting. It is for the pen of an authority to settle this point.

Several times already I have remarked facts confirming the influence of the graft upon the stock. As to the inverse case, that is to say, the influence of the stock on the graft, I have never observed it, although it may also be produced, as is shown by the experiments made by M. Daniel, doctor of science, professor at the Lyceum of Rennes, experiments which he reported to the Pomological Congress of Rennes in 1897, and subsequently at the Horticultural Congress of Paris in May 1898.

This year, in the nurseries at Plantières, on a common Birch, there was produced a branch with laciniated leaves: this Birch had been grafted this spring, with a variety with laciniated leaves, but the graft had failed. The sport is produced far below the point where the graft had been inserted; a fact which astonishes me, since, in the analogous cases above cited, and especially with Maples, transformed branches spring from a point in close proximity to the graft, if not immediately below it.

The charming *Cornus alba Spaethi*, so well known in cultivation, is the issue—though few horticulturists know it, even among those who cultivate extensively this superb shrub with margined foliage—of a branch which arose, at the base of the grafting point, upon a *Cornus alba* grafted on *Cornus alba fol. arg. marg.*

The raiser of this variety, M. Spaeth, whom I consider to be one of the most distinguished among German nurserymen, distinctly attributes this variation to the influence of the graft upon the scion.

The following fact, extracted from the *Bulletin* of the Horticultural Congress held at Brussels in April 1864, simply confirms what I have advanced above.

M. Dr. Rodigas, at the time when he was directing the Horticultural department connected with the Normal School of Lierre, had grafted a

dormant bud of *Cratægus ox. fl. puniceo* upon the stem of a *Sorbus aucuparia*. The bud had been inserted about 1 metre above the ground. This was in July. The following spring, the bud started and attained a length of 0·05 m. to 0·06 m. Then the leaves dried up, but at the same time, on the opposite side and at about 0·18 m. below the point of insertion of the graft-bud, there was developed a true bud of *Cratægus*, the leaves of which soon acquired half their normal size; they were healthy and well characterised. In its turn, however, this bud died off. The stem was then at this point 0·09 m. in circumference. It was perfectly smooth and no trace of insertion of another graft-bud was perceptible, even with the aid of a fairly strong lens, whilst the cicatrice of the shield remained clearly defined, as is always the case in similar circumstances. The bud besides had sprouted precisely as an adventitious bud would do. Such is the fact, of which I guarantee the authenticity. I leave it to investigators of physiological mysteries to explain this strange phenomenon. Is it possible that a cell containing within it the vital germ of the *Cratægus* has been able to be carried from the point of insertion to the point whence the bud has emerged to daylight at 0·18 m. below and on the opposite side? Has the affinity which exists between two neighbouring genera, *Sorbus* and *Cratægus*, been sufficient to assist the production of this? I would not venture to say so. But I should be glad to obtain some explanation of this curious fact.

If now we compare the curious and interesting *Cytisus Adami* with the Bronvaux Medlar, we are struck with the great analogy between the different transformations remarked upon these two trees, and I ask myself whether *Cytisus Adami* has not also been produced by the influence of the graft.

According to M. Adam, who raised it, this Cytisus was the result of the graft, but his opinion was vigorously combated, and generally considered to be erroneous.

It seems to me, however, that the declaration of the raiser should have prevailed over the different suppositions and hypotheses which were formed resting on no substantial basis. The following is what is recorded regarding this Cytisus.

It was raised in 1825 by M. Adam, nurseryman at Vitry, near Paris, who put it into commerce under the name of the *Grand Cytise d'Autriche* because it presented some resemblance, especially as regards the colour, to *Cytisus purpureus*, which was known under the name of *Cytise d'Autriche*.*

In 1830 M. Prevost, a nurseryman at Rouen, reports, for the first time, that this new Cytisus had spontaneously developed upon a purple Cytisus ("Ann. de la Soc. d'Hort. de Paris," vii. p. 93).

M. Poiteau follows up this communication with the following note:

"This," says M. Poiteau, "is what M. J. L. Adam told me. 'In 1825 I shield-grafted, according to my custom, a certain number of purple Cytisus (*Cytisus purpureus*) on as many stocks of Alpine Cytisus (?) (*Cytisus Laburnum*). One of these buds has lain dormant a year, as is often the case, and during this time it has multiplied considerably, as is also often the case. The second year all the eyes of this shield-bud

* Probably because *C. purpureus* is a native of Austria.

started, and among the shoots which have resulted from them I have noticed one which was distinguished from the others by its greater development, by a vertical growth and by much larger leaves, somewhat like those of the Alpine Cytisus. Then I grafted and multiplied this branch, hoping that it would be an interesting variety, but having always sold the trees as fast as I multiplied them by grafting, I have never seen the flower.' I had hoped," says M. Poiteau, "that M. Adam would have shown me the tree upon which this phenomenon had been developed, but he had sold it with the others. He believes that this tree passed into the possession of M. Fremont, nurseryman at Rouen, who, probably, in his turn, will have delivered it to one of his customers. I was the more curious to see this tree, as I suspect that the new Cytisus in question is not the result of the grafting, but really an accidental development of the stock *Cytisus Laburnum*, which had already undergone the change attributed to the graft of the *Cytisus purpureus*, and that this stock had pushed out a branch amongst those of the graft. M. Adam might have taken this branch for one of those produced by the graft. I base my suspicion on the great resemblance which exists between the new Cytisus and the old Alpine Cytisus, and also on its very slight resemblance to the purple Cytisus.

"I am, however, far from confident that M. Adam is mistaken; sports are often seen to develop on a tree and to be fixed by grafting by the cultivator—it is thus that I have myself seen the *Morus cucullata* developed in its entirety on *Morus papyrifera*.

"It is known that several Roses have no other origin; but these plants resemble their mother more than anything else, whilst the new Cytisus does not at all resemble the purple Cytisus,* of which M. Adam states it was the issue, and, furthermore, there is no longer evidence that a shield-graft was necessarily concerned in its first development."

I will not discuss the above statements regarding *Cytisus Adami*. I leave them to the appreciation of the reader. For myself I believe that this Cytisus is, like the issue of the Bronvaux Medlar, to be considered as a hybrid obtained by grafting. I conclude with the following reflection:

If there had been known, as there are to-day, facts proving irrefutably the influence of the graft, the information of M. Adam would never have been disputed, and *Cytisus Adami* would certainly have been considered, at least by many persons, as a hybrid produced by grafting. But this theory not being admitted, it has been sought, especially when this tree has commenced to sport, to explain the phenomenon in another manner.

* At this epoch *Cytisus Adami* had not yet sported (therefore had not yet produced branches of *C. purpureus*), and it is probable that if M. Poiteau had known the phenomena which were subsequently produced, his opinion would have been different. It was in 1833 that this tree produced the first branches which had been noticed of *C. purpureus*. The fact was made known to the Société d'Horticulture of Paris by M. Camuzet, then head gardener to the Natural History Museum.

OBSERVATIONS ON SOME HYBRIDS BETWEEN DROSERA FILIFORMIS AND D. INTERMEDIA.*

By Prof. J. MUIRHEAD MACFARLANE, D.SC.,

Professor in the University of Pennsylvania, U.S.A.

ACCOMPANIED by a few of my students, an excursion was made, during the third week of June, to the rich botanising grounds near Atco, N.J. Amongst the pine-barren swamps of that locality was an area, several acres in extent, which was partially flooded, but clothed with a profuse surface vegetation of swamp or bog plants. These consisted almost entirely of the four species *Eriocaulon septangulare, Drosera intermedia, D. filiformis*, and a yellow-flowered *Utricularia*.

The later blooms of *D. filiformis* were still abundant, but the involute flower stalks of *D. intermedia* were just unrolling, and, as was proved later, these did not bloom fully till the second week of July. Casting one's eye across the swampy mass of vegetation, the clusters of pale pink elongated leaves of *D. filiformis* contrasted strongly with the short dense clusters of crimson-pink leaves belonging to *D. intermedia.*

After a considerable stretch of the marsh had been examined, my attention was arrested by a rather distant group of plants, somewhat intermediate in height and colour between the two common species around. A nearer examination of the eleven plants composing the group suggested the possibility of their being natural hybrids between the above-named species. They were carefully removed, without injury, to one of the greenhouses in the University Botanic Gardens, where they have since been grown and watched. A continued and careful exploration of the swamp failed to reveal the presence of additional plants or plant clusters like those already found.

Detailed comparison of the leaves, flower stalks, inflorescence, flowers, and period of blooming still further confirmed the suspicion entertained on finding them. Histological investigation of the three, as well as of *D. rotundifolia*, which was only sparingly present in the marsh, shows that the last-named species does not contribute to the formation of the plants in question. It equally demonstrates a minute blending, in all parts of the hybrids, of the histological peculiarities of *D. filiformis* and *D. intermedia.*

When the eleven specimens were collected, care was taken to remove sods of both parent species, and all three were grown in neighbouring flats in the greenhouse. The parent species matured an abundance of what seemed to be good seeds. The contents of the hybrid pods were apparently useless. A detailed description of the macro- and micro-morphology of each will now be given under the following heads: (*a*) leaves, (*b*) axis of inflorescence, (*c*) inflorescence, (*d*) period of blooming, (*e*) size and colour of the blooms, (*f*) floral structure.

* This note first appeared in the publications of the University of Pennsylvania, and was kindly sent over by Dr. Macfarlane to the Conference, with living specimens of the hybrid and its parents.—ED.

(a) *Leaves.*—The leaves of *D. filiformis* (fig. 105, No. 1) are on the average 8 inches long and $\frac{1}{12}$ inch wide. The statements made in current botanical manuals that there is "no distinction between blade and stalk," * also that they are "glandular-pubescent throughout,"† are equally incorrect. A non-glandular portion $\frac{3}{8}$ to $\frac{5}{8}$ of an inch long is the petiole, and in the winter bud-leaves, is the only part developed for protective purposes. The base of this non-glandular part is a flattened quadrangular area $\frac{1}{8}$ inch by $\frac{1}{4}$ inch. It is densely tomentose-pubescent along its lateral and uper margin, as well as externally. The individual hairs vary greatly in size, in the number of cells composing each, and in the amount of their branching. While some consist of a few cells joined lengthwise into a long thread which may give off one or two attenuated branches, the majority are long flat ribbons that give off numerous narrow branches.

The upper epidermal cells of this area are of varying shape and size, but average $150 \times 38\ \mu$. They contain relatively few scattered small chloroplasts, each $2 \cdot 5$–$3\ \mu$ across. Stomata are not present over this area. Its outer or lower epidermis consists of longer but narrower cells, $185 \times 20\ \mu$, which are well filled with large chloroplasts, each $7 \cdot 5$–$8\ \mu$ across. Amongst these are a few stomata, each 40×23–$25\ \mu$. More abundant than the stomata are two-celled sessile glands of stoma-like character, each cell being filled with rich finely granular substance and a highly refractive nucleus.

The leaves of *D. intermedia* (fig. 105, No. 3) are on the average $1\frac{1}{2}$ inches long, and in the blade $\frac{1}{5}$ inch wide. There is a sharp differentiation between petiole and blade, the latter becoming both widened out and glandular at its junction with the former. At the base of the petiole there is, as in *D. filiformis*, a somewhat quadrangular area, but here the edges slope toward the upper part of the area. It is glabrous throughout, except across the upper transverse boundary, where are seven to ten strong multicellular unbranched, or slightly branched, hairs. The epidermal cells are $225\ \mu \times 28\ \mu$, and contain a very few small chloroplasts.

The lower epidermis of this area consists of elongated narrow cells measuring 200–$225\ \mu \times 15\ \mu$. It has no stomata, and instead of the two-celled glands of *D. filiformis* are glandular bifid hairs (fig. 105, No. 4*c*).

In the hybrid the leaves vary considerably according to age and position in the annual rosette, but comparison of its leaves with those of *D. filiformis* and *D. intermedia* proves that this variation is an inherited one from both parents. The earlier leaves of the annual rosette in *D. filiformis* are comparatively short and taper to a somewhat blunt point; the typical summer leaves may be 10–11 inches long and greatly attenuate at their tips. In *D. intermedia* the spring leaves decidedly approach in outline to those of *D. rotundifolia*; those of summer develop as the typical spathulate growths. We have here a key to the degree of variability seen in the hybrid. The first growths of a rosette consist of leaves which are $1\frac{3}{4}$–2 inches long, the glabrous petiole being $\frac{1}{2}$–$\frac{5}{8}$ inch long, the remainder being lamina. The summer leaves are on the average $3\frac{1}{2}$ inches long, of which $\frac{7}{8}$–1 inch may be petiole. The basal quad-

* Gray's *Manual of Botany*, 6th edit., 1889.

† Britton and Brown's *Illustrated Flora*, vol. ii. p. 162.

rangular area is very averagely intermediate alike in size and shape between that of each parent. Numerous hairs, which are structurally identical with those of *D. filiformis*, occupy a like position, but they are considerably shorter and show fewer branchings. Across the upper transverse boundary a few rather stronger hairs stand out amongst the more flattened ones, as an inheritance of the few prominent hairs of *D. intermedia*. The upper epidermal cells are 188–200 $\mu \times 32\,\mu$, while the chloroplasts are very small and scarce.

The cells of the lower (outer) epidermis are on the average 186–195 $\mu \times 21\,\mu$, and the chloroplasts measure 2·5 μ. Numerous two-celled sessile glands are inherited from *D. filiformis*, but the bifid hairs characteristic of the other parent are also present, though considerably reduced in size.

It is not the intention to deal in this paper with the details of internal leaf anatomy, and accordingly a short comparison may now be made of the thre forms, in their petiolar region, between the base and lamina. In all, the two-celled glandular or bifid hairs are abundant, and study of the figures 4*a*, 4*b*, and 4*c* on fig. 105 will graphically illustrate their relative size. In *D. filiformis* they are only slightly elevated above the epidermis on subjacent cells, and they measure 28 $\mu \times 18\,\mu$. In *D. hybrida* they are saccular elevations above the epidermis, and measure 33 μ high by 32 μ across. In *D. intermedia* the hairs are bifid bladder-like appendages, each 45–50 μ high by 37 μ across.

Stomata are now present over the under surface of the three and show noteworthy differences. Those of *D. filiformis* are 38 μ long by 24 μ wide, and one guard cell is usually larger than or somewhat obliquely placed to the other, while a more or less evident sinus exists at their opposed ends (fig. 105, No. 6*a*). The chloroplasts of the guard cells are 20–22 in number, and measure 3·2 μ across. In the hybrid the stomata are on the average 32 $\mu \times 25\,\mu$, and show a very slight tendency toward inequality of size or position (No. 6*b*). The chloroplasts are 15–17 in number and measure 2·5 μ across. In *D. intermedia* the stomata measure 26 $\mu \times 25\,\mu$; the guard cells are very neatly crescentic and fitted at their ends (No. 6*c*). The chloroplasts are 12–14 in number and measure 1·8 μ across.

The blade of the leaf is tentacular throughout on its upper surface. The general colour of the lamina of the three forms is markedly different. Leaves of *D. filiformis* might be described as pinkish-green, those of *D. intermedia* as deep crimson green, while those of the hybrid are averagely intermediate to the naked eye. Microscopically examined, these differences are found to be due to the relative distribution of a rich crimson-red pigment, which is only present in the tentacular hairs. In *D. filiformis* it is wholly confined to the oval or elliptic head of each hair, there being a sharp contrast in colour between the green top of the hair-stalk and the red base of the head. In *D. intermedia* the pigment is richest in the head, but is distributed in the cells of each hair throughout two-thirds of its length. In the hybrid the pigment is less rich than in the last, and extends throughout one-third to rarely one-half the length of the stalk.

The tentacular hairs of all three vary greatly in length, so that no exact comparison is possible. The club-shaped head of each in *D. filiformis*

is broadly elliptic, and is on the average 220 × 165 μ. The head of each hair in *D. intermedia* is ovate-truncate and measures 230 × 105 μ. That of the hybrid is elliptic-ovate in outline and measures 210 × 125 μ.

The upper laminar epidermis of *D. filiformis* consists of cells which are highly variable in size and shape. Stomata are abundant, as many as nine being in a circular area 300 μ across. Each stoma measures 40 × 30 μ. Four-celled sessile glandular hairs are also disposed over the epidermis. The stomata and glandular hairs of the lower epidermis are about equally as abundant as those of the upper epidermis. The upper epidermis of *D. intermedia* has on the average seven stomata over the above-named area, and each measures 27 × 22 μ. Two-celled glandular hairs take the place of the four-celled ones of the other parent. In the hybrid an average of eight stomata is observed in the above area, and each measures 34 × 25 μ. There is a curious admixture of the glandular hairs. Some are two-celled only, as in the latter parent, others are four-celled, as in the former, while not a few are three-celled owing to a median or somewhat oblique wall crossing one of the twin cells. On the lower epidermis the same peculiarity occurs, though in leaves examined the majority were two-celled, as if the glandular tissue swayed toward one parent. Suggestive cytological considerations come up here of which we shall speak later. Chloroplasts occur in all epidermal cells, but these vary considerably in different cells and individuals, so that exact comparison seems impossible.

(*b*) *Axis of Inflorescence.*—Comparison of a considerable number of axes of the parents with the eleven of the hybrid indicates that the average height of that in *D. filiformis* is 9¾ inches, in *D. intermedia* 5½ inches, and in the hybrid 6¾ inches. Here it should be noted that the average heights given for the parents have been taken from the plants growing in several localities, and that the hybrids do not seem to have attained the age vigour which may yet be expected. This may to some extent affect the length of the axis.

Surface views of the epidermis of the axis show a quite glabrous surface in *D. filiformis* with stomata in considerable numbers, each measuring 40–44 μ in length. That of *D. intermedia* is provided with stomata which are 35 – 36 μ in length, but about as abundant as these are the two-celled glands typical of the species. In the hybrid the stomata average about 38 μ, while the two-celled glands of the latter parent are reproduced in size, but reduced in number.

A slight reference may be made now to the structure of the cortex. In *D. filiformis* this is made up of 4 – 5 rows of thin-walled, richly chlorophylloid cells, with considerable intercellular spaces between. An indurated sclerenchyma zone next succeeds, composed of 5 – 6 layers of cells, which gradually become larger towards the interior. The amount of thickening is greatest in the second and third layers of sclerenchyma. The average thickness of the thickest walls is 7 – 8 μ. The chlorophylloid cortex of *D. intermedia* consists of 1 – 2 layers of cells with fairly large intercellular spaces between. Subjacent to this are 3 – 4 layers of slightly indurated, but mostly very large, cells from the second layer inwards. The average thickness of the walls is 3·5 μ. The outer cortex of the hybrid is made up of 2 – 3 layers of chlorophylloid cells, with relatively

large intercellular spaces. Subjacent are four to five sclerenchyma layers considerably less thickened than in *D. filiformis*, but which have, as in it, the most highly thickened zone in the middle of the mass. The average thickness of the thickest wall is 4·5 μ.

The fascicular system will not now be treated of, as equally in parents and hybrid it is complicated in arrangement.

(*c*) *Inflorescence.*—The scorpioid cyme of *D. filiformis* is, from the bud state onward, semi-erect, and the flowers are closely crowded along the false axis, against which they are closely adpressed. The number of flowers in an inflorescence averages 14. The cyme of *D. intermedia* is closely coiled in the young state, the component blooms are somewhat loosely arranged: they spread out in radiate fashion from the false axis, and the average number of flowers is 8. The cyme of *D. hybrida* is rather strongly incoiled, as in the latter parent. The blooms average 10, and these are set in a rather scattered sub-secund manner along the false axis.

(*d*) *Period of Blooming.*—In my paper on "Plant Hybrids"* I advanced a considerable body of facts to prove that the flowering period of many hybrids is very exactly intermediate between the periods of the parents, while other hybrids show a decided divergence toward one parent. It has not been possible to do more in the present study than to ascertain approximately the relative period of blooming. From a study made at several localities in New Jersey during the past season, it was learned that the first blooms of *D. filiformis* opened on June 7–10, and by June 28 the terminal flowers of the cyme were open. When collected on June 30 a number of the lower flowers on the more vigorous hybrid plants had already passed, while the lowest flowers on small plants and the lower middle flowers on strong plants were fully open. The plants continued to flower in the University greenhouses till August 3. As already noted, when plants of *D. intermedia* were gathered the involute flower stalks were just unrolling, and later observation showed that this species begins to bloom about July 3, and continues until about August 15. In attempting to account for the origin of the patch of hybrid plants, therefore, it seems extremely likely that a late bloom of *D. filiformis* and an early bloom of *D. intermedia* had been concerned in the pollination process. The limited observations just recorded point to *D. hybrida* as a form which blooms at a period between those for the parent species. It should be said, however, that the writer and another member of the party succeeded in obtaining some four blooms of *D. filiformis* on as many plants as late as August 10. That they were entirely out of season was proved by hundreds of surrounding plants having their capsules in an advanced state of maturity.

(*e*) *Size and Colour of the Blooms.*—Those of *D. filiformis* are on the average $\frac{1}{2}$ inch across, though they vary more than do those of the other parent. They are of a purple-pink hue. The petals of *D. intermedia* are $\frac{1}{4}$ inch across and of a pure white colour. Those of the hybrid seem decidedly to approach the latter, since the flowers are $\frac{3}{8}$ inch across, and are white with a faintly recognisable pink flush.

(*f*) *Floral Structure.*—The sepals form an exceptionally interesting

* *Trans. Roy. Soc. Edin.* vol. xxxviii.

study. Those of *D. filiformis* are abundantly covered externally with glandular hairs (fig. 105, No. 7*a*) which vary greatly in structure and length. They may be from 180–380 μ long. Generally it may be said that all of them end in a flat-topped mass of 4–12 glandular cells, but the stalk supporting these may be a single cell row or two rows below gradually running into one or two rows above. Each stalk also consists of 3–6 or 7 tiers of elongated cells. In the distal hairs of each sepal spiral tracheæ may enter the base of the hair and soon end blindly, or may be prolonged about one-third the length of the hair. Rosette-shaped, four-celled, sessile glands, and toward the base of the sepals two-celled glands of similar appearance, are also disposed over the exterior. Stomata are abundant, are nearly circular in outline, and measure 30 × 28 μ. The internal (upper) epidermis is glabrous, and consists, like the upper epidermis, of very variable cells, alike in size and shape. In *D. intermedia* the outer surface of each sepal is glabrous, but a moderate number of two-celled glands on a slight stalk cell, as well as stomata, occur over its surface. In *D. hybrida* the outer surface of each sepal bears the same type of stalked gland hair as is seen in *D. filiformis* (No. 7*b*), but here they are on the average only one-third to one-fourth the length of those on the parent species. But, like the parent, they vary in structure amongst themselves. Besides these are the four-celled sessile glands, which differ in no way as to size from the parent, each being 30 μ across. They are more scarce, however, than in the parent. We thus have the interesting case shown of one type of parental hair inherited in greatly reduced numbers and of much smaller size, and another type inherited in reduced numbers, but of exactly the same size. Still further, the hybrid inherits bilobed glands from *D. intermedia* in moderate quantity. Three types of epidermal glandular appendage are thus inherited by the hybrid from its parents.

I do not propose to describe in detail at present all the points of floral or fruit and seed structure. The careful observations of another season will be needed before exact comparisons can be made. It may be said, however, that the pollen grains of *D. filiformis* are richly granular, largest in size, and measure 56 μ across. Those of *D. intermedia* are also granular and plump: they measure 44 μ across. Most of the hybrid grains are more or less starved or poor in protoplasmic substance. They measure 48–50 μ, so that development of the pollen grain walls has proceeded perfectly, though the enclosed fertilising substance appears to be imperfect. The ovules and seeds of both parents matured well; those of the hybrid remained small and in most instances developed as empty or nearly empty shells. Cultivation and future study will demonstrate how far this may be a constant character.

The naked eye and histological details described above emphasise the position first fully established by the writer* that a hybrid is, as a rule, down to its minutest details, a blended reproduction of both parents in which the morphological and physiological details of each are reduced by half. In no case has it been possible to detect the entire loss in the hybrid of some parental condition, and this cannot be too strongly insisted on in view of the loose theoretical reasonings often indulged in

* *Trans. Roy. Soc. Edin.* vol. xxxvii. p. 203.

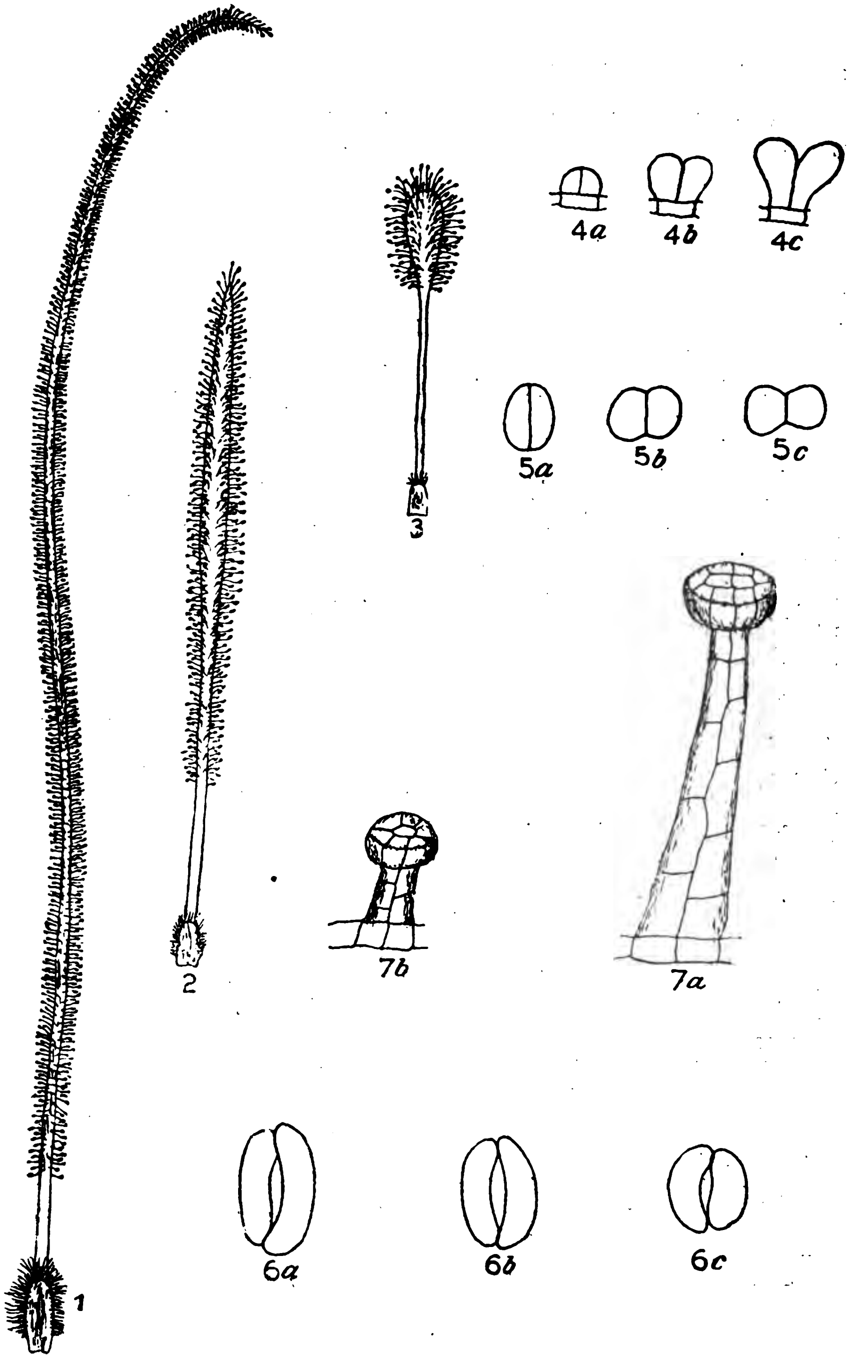


FIG. 105.—HYBRID DROSERA AND ITS PARENTS.

1.—Leaf of *Drosera filiformis.*
2.—Leaf of *Drosera hybrida.*
3.—Leaf of *Drosera intermedia.*
4*a.*—Gland cells of *Drosera filiformis*; 4*b*, of *D. hybrida*; 4*c*, of *D. intermedia*, all in vertical view.
5*a*, 5*b*, 5*c*. –Surface views of last.
6*a.*—Stoma of *D. filiformis*; 6*b*, of *D. hybrida*; 6c, of *D. intermedia.*
7*a.*—Capitate glandular hair from sepal of *D. filiformis*; 7*b* do. do. of *D. hybrida.*

now on questions of heredity. Peculiarities of structure, and equally, it seems, of function, are not readily lost, but may persist, in a gradually reduced state, in several succeeding generations.

A glance at the comparative results, however, equally demonstrates that in this, as in some other hybrids studied, certain parts or organs tend more toward one parent than another. The balance of development throughout in the present case is evidently toward *D. intermedia.* Thus, in the relative size of the tentacular hair heads, in the amount of thickening of the indurated cortex cells, in the greatly reduced size of the glandular hairs of the sepals as inherited from *D. filiformis*, and in the colour and size of the flowers, there is a decided preponderance in morphological detail of *D. intermedia* over the other parent, or the former exercises a certain swamping effect on the growth vigour handed down from the latter parent. This is all the more remarkable when one considers that the apparently prepotent parent is the smaller and more delicate species. Until facts can be obtained on which to base an exact explanation we can at best merely theorise. But I would again advance as a highly probable hypothesis the view given in my earlier paper, viz. that the sex cells of the pollen grain or of the ovule may have attained to a greater size in the smaller species, and may have contained a larger amount of hereditary chromatic substance. In the graft hybrid *Cytisus Adami* admirable and direct evidence is afforded of a much smaller species, *Cytisus purpureus*, having greatly larger nuclei and more chromatin apparently in its epidermal cells than the larger species, *C. Laburnum*, which has contributed with it to the formation of the graft hybrid. The graft hybrid itself closely resembles the smaller species in the size, appearance, and relation to stains of its epidermal nuclei, not to mention other and more evident characters. A like condition may exist in the hybrid and parent forms of *Drosera*, even though scarcely, if at all, discernible under the microscope. It is hoped that a careful study can yet be made of this feature with the material now under cultivation.

The phenomenon which the writer termed bisexual hybridity receives several striking exemplifications. Where two more or less diverse growths have occurred, one on either parent, these have been shown to be reproduced, not in blended fashion, but as distinct structures reduced either in size or number, or both. The elongated glandular hairs on the sepals of *D. filiformis* and the sessile two-celled glands of *D. intermedia* alike appear in the hybrid. Such a morphological pattern is frequent in hybrids whose parents are somewhat removed in systematic affinity, and suggests interesting cytological speculation. For, if every cell in the hybrid be, as its structure proclaims it to be, a combined effect of two parental conditions, each reduced by half, some appropriate explanation must be given to the special case before us. As yet we have no evidence which would militate against the view, and everything is in favour of it, that every a erage cell of a hybrid has an equal number of chromosomes and half as much chromatic substance as is found in each parent. But for the production of two such epidermal appendages some special line of development must have been taken by the epidermal cell which gave rise to each. The view would be an imperfect one which would cause us to suppose that chromosomes representative of one parent were alone present

in such epidermal cells. It will be more consonant with the principles of heredity if we suppose that at a certain cell centre in the epidermis a special growth-potentiality is inherited from one parent that stimulates to the formation of a hair characteristic of it, and that while the hereditary influence of the other parent, that is devoid of such hairs, is sufficient to reduce or check back growth of the hair to at least half the size of the parental one, it fails to prevent the development of a structure peculiar to one parent alone. Neither is there any need to suppose that there is a separation or sorting out of chromatic elements in the process. Side by side on the same spirem thread of the epidermal cell which produces such a hair elements of both parents may exist, and similiarly also in each cell that contributes to the hair formation. But the decidedly reduced size, in the hybrid, of the glandular hairs inherited from *D. filiformis* seems evidence that there is a marked prepotency of the chromatic substance of the other parent over the average. It is not too much to hope that some of these hypothetical problems my yet receive full verification.

EUCALYPTUS HYBRIDS IN THE MEDITERRANEAN REGION.

By Dr. TRABUT, of Algiers.

IN these days we do not hesitate to admit that all the causes which tend to variation may contribute to the genesis of new species, and hybridisation, without doubt, is in many cases the point of departure for new forms which, in time, become fixed species, and have a place either in nature or under cultivation.

The genus *Eucalyptus* furnishes, in the Mediterranean region, a very evident demonstration of this principle.

A hundred Eucalypti have been acclimatised in the North of Africa during the last thirty years. The most remarkable collection is that of M. Cordier, at his estate of El Alia, at Maison Carrée, near Algiers.

When one tries to classify the trees which are raised from seed gathered in these collections, great difficulties are experienced, and some of them one is tempted to describe as new species not yet observed in the country of their origin.

In 1886, having made a sowing of seed gathered from a *Eucalyptus botryoides* in the garden of the City Hospital, I was surprised to find about 60 per cent. of young plants very different from the seed-bearer. The same observation may be made regarding the sowings made in the following years. The inflorescences and the fructifications of all these trees, studied with care, have enabled me to establish that the *Eucalyptus botryoides* from which I gathered my seed could have descendants of two sorts :—

(*a*) *Eucalyptus botryoides*. True.

(*b*) *Eucalyptus*. Very different. Evidently hybrids.

The only Eucalypti existing in the immediate vicinity of the seed-bearing *botryoides* were *E. rostrata*.

The new form corresponded well to the combination *botryoides* × *rostrata*. It has also a very great resemblance to the *E. resinifera* (Sm.), a rather polymorphic type.

For eight years I have multiplied this Eucalyptus, and I observe that the plants resulting from the first hybrids have well maintained their principal characters, while presenting, like many of their congeners, very numerous individual variations. It is on account of this fixity that I have described this Eucalyptus as a new specific type, although it is certainly the outcome of a chance hybridisation. These are its characters :—

Eucalyptus Rameliana=*E. botryoides* × *rostrata* (Trabut).

Tree of very rapid growth, branching at a very early stage, and assuming a regularly pyramidal habit; foliage dense, of a sombre green; leaves leathery, oval lanceolate, slightly arched, very pointed, delicately veined, length 15 to 22 centimetres, width 30 to 45 millimetres. The two surfaces are distinct, the upper one, more glossy, having about 70 stomata per square millimetre; the under surface, which is paler, has

150 stomata per square millimetre. It should be noticed that in *E. botryoides* the leaves have stomata only on the under surface, 200 per square millimetre; in *E. rostrata* the stomata are distributed on both surfaces alike. The angle of divergence of the secondary veins is equal to 55°–60°—midway between the angle of divergence of *botryoides* (65°–70°) and that of *rostrata* (45°–50°). The inflorescence is in axillary umbels carried upon a peduncle, a little flattened below the flowers, which have a short pedicel equalling the calyx-tube; their number varies from seven to twelve. The buds have an operculum of conical form, in most cases slightly beaked. The fruit is the size of a pea, and semi-oval, with the calyx-tube passing sometimes beyond the capsule, which at maturity opens by valves whose extremities are withered and dead.

This character shown in the valves is very interesting. In *E. rostrata* the valves remain entire, standing erect, leaving the cells wide open; in *E. botryoides* the valves wither and fall; in *E. Rameliana* the extremity only of the valves is withered—it is an intermediate case between the very different dehiscences of the two parents.

By its vigour, the regularity of its outline, and the density of its foliage, this Eucalyptus deserves attention.

Among the sowings made with seeds derived from the Cordier collection, there are often found new and very interesting forms, generally robust.

My colleague, Dr. Boulier, has on his property a number of these plants which are already well developed; particularly noticeable are—

1. A Eucalyptus, probably a hybrid between *gomphocarpus* and *cornuta*, having a certain resemblance to *E. occidentalis*.

2. A *E. Gunnii* × *globulus* (?).

3. A *E. Cornuta* × *Lehmanni*.

In many of the cases it is not possible to determine exactly the species which has furnished the pollen—it can only be conjectured.

From these observations, carried on for twelve years, it is proved that certain species of the genus Eucalyptus cultivated in the Mediterranean region can intercross and give birth to new types very distinct and having absolutely the appearance of legitimate species. Certain of these forms have progeny possessing a fecundity and a fixity which are very remarkable.

These hybrids are interesting from the practical point of view, because they prove to be very robust and very foliose, and it is probable that some will eventually be preferred to the typical species introduced from their native country.

ON THE PARTICULAR INFLUENCE OF EACH PARENT IN HYBRIDS.

By Dr. L. Wittmack, Berlin, Corresponding Member of the Royal Horticultural Society.

There are two important questions in connection with crossing which cannot be replied to in a general way, as the factors differ in every family or genus. These are:—

Which parts in the hybrids are influenced by the father and which by the mother? And

Whose influence is the greater?

Obviously the questions become the more complicated when the parents themselves are not true species, but are already hybrids. My experiences, relating chiefly to cereals and Bromeliaceæ, tend to show that the mother plant usually determines the habit, that is, the vegetative portion; while the father has the greater influence upon the floral parts, and, in Bromeliaceæ especially, upon the colour.

An example illustrating this is seen in the hybrid raised by Dr. Rimpau, of Schlanstedt (now in Langenstein) between Wheat ♀ and Rye ♂. The habit of this plant is like that of Wheat, and also the glumes are more or less boat-shaped, as in Wheat, but the form of the ears, the length of time the spiculæ remain open at the flowering period, and the longer antheræ indicate decidedly the paternal influence.

A second instance is seen in the recently announced hybrid between Zeeland Wheat and Squarehead Wheat, which has been raised by Professor Broekema, Director of the Royal Agricultural School at Wageningen, in Holland. If he used the Squarehead as father the ears became closer, resembling the Squarehead; also the upper limb of the stalk became thick as in that variety; if, however, he used the Zeeland form as father, the ears became longer, more pointed, and the upper stalk limb thinner, agreeing thus with the character of the Zeeland ears.

Many instances may be cited in the Bromeliaceæ, and I am indebted for a rich supply of material of this family to different gardeners, especially to the head gardener Mr. Kittel, hitherto in Eckersdorf, but now in Breslau, Silesia, well known through his crossings, and to other gardeners. Many hybrids are delineated in the German "Garten-Zeitung" and in the "Gartenflora."

I may mention:—

1. *Billbergia hybrida Worleana*, Wittmack (Billbergia nutans ♀ × B. Moreliana ♂), in which the whole inflorescence is nodding as in nutans. The petals, however, are not green, but dark blue, as in Moreliana ("Deutsche Garten-Zeitung," 1886, p. 459, with illustration).

2. *Billbergia hybrida Gireoudiana*, Kramer and Wittmack (Saundersii ♀ × thyrsoidea ♂), which shows the white spotted leaves of the mother, but in lieu of her pendent inflorescence the upright spike of the father ("Gartenflora," 1887, p. 330).

3. *Billbergia Breauteana*, E. André (vittata ♀ × pallescens ♂), which

certainly inclines the more to the mother ("Gartenflora," 1888, p. 521, plate 1282).

4. *Billbergia hybrida Krameriana*, Wittm. (thyrsoidea ♀ × amœna ♂), has inherited from the father the strongly ribbed ovaria and the smaller number of bracteæ; the lower flowers are also only provided with one bractea, as in the father ("Gartenflora," 1888, p. 657).

5. *Billbergia Windii*, Hort. Makoy (nutans ♀ × decora ♂), has the pendent habit of the mother and her mainly green petals; but, on the other hand, has the numerous bracteæ and the entirely reflexed petals of the father ("Gartenflora," 1889, p. 7, with illustrations).

6. *Billbergia Perringiana*, Wittm. (nutans ♀ × Liboniana ♂), has the habit of the mother, but the beautiful indigo colour of the petals of the father ("Gartenflora," 1890, p. 145, pl. 1318).

7. *Billbergia Wittmackiana*, Kittel (amœna ♀ × vittata ♂), has the pendent inflorescence of the father, the habit and the leaves of the mother ("Gartenflora," 1891, p. 328).

8. The difference between reversed crosses in Billbergias is very beautifully shown in the examples of H. Witte in Leyden, as described and illustrated in "Gartenflora," 1891, p. 563:—

a. Billbergia Leodiensis, H. L. B., is raised from vittata ♀ × nutans ♂, and has the broad growth and broad leaves of vittata.

b. Billbergia intermedia, H. L. B., the reversed cross, shows much narrower flaccid leaves, which nearly approach those of the mother.

The illustrations given (*l.c.*) are very striking.

The influence is also very strikingly shown in several species of Vriesea; for instance:

9. *Vriesea Wittmackiana*, Kittel (Vriesea Barilletii ♀ × Morreniana ♂), which has united the dense two-lined spikes and the fine dark red points upon the bract leaves of the mother with the magnificent scarlet red and golden yellow colour of the bract leaves of the father ("Gartenflora," 1888, pp. 287, 553, pl. 1283).

A similar and equally beautiful product is *Vriesea Mariæ* (E. André in the *Journal Soc. Nat. Hort. France*, 1889, p. 577) (Vriesea Barilletii ♀ × brachystachys ♂). Vriesea brachystachys, or carinata, is to a certain extent only a denser form of Vriesea Morreniana or of psittacina. Furthermore may be named—

10. *Vriesea Alberti.* E. André (V. incurvata ♀ × Morreniana ♂), *Revue Horticole*, 1889, p. 300. It resembles V. incurvata more in its spike, but the bracts are not so incurved.

11. *Vriesia Magnisiana*, Kittel and Wittm. (Vriesea Barilletii ♀ × fenestralis ♂). This has almost as dense a spike as in Barilletii, whilst fenestralis has a looser one. It shows, however, the separated large tips upon the bract leaves as in fenestralis, not the numerous small points of Barilletii. The leaves are a trifle more reticulated than in Barilletii, and not so much as with fenestralis ("Gartenflora," 1889, p. 343, with illustration).

12. *Vriesea insignis*, H. L. B. (Barilletii ♀ × splendens ♂). Habit of the mother, but the scarlet tint of the bract leaves of the father is, at any rate, so far transmitted that the closely set dark points of Barilletii have disappeared and the bract leaves are uniformly tinted

wine red ("Gartenflora," 1892, p. 1, pl. 1862, and illustrations in black).

A beautiful hybrid is

13. *Vriesea Pommer Escheana,* Wittmack (Morreniana ♀ × splendens ♂), raised by Kittel. It has inherited most from the mother, which itself is a hybrid (psittacina ♀ × carniata ♂). As shown in "Gartenflora," 1892, p. 311, and "Gartenflora," 1893, p. 129, pl. 1388—it has the beautiful red bract leaves, without yellow tips, of the father, but, singular to state, the black cross-bandings on the leaves of the father, Vriesea splendens, are not inherited at all, which also occurred with Vriesea fenestralis × splendens, raised by M. F. Duval at Versailles ("Gartenflora," 1893, p. 306).

14. *Vriesea Weyringeriana* (Barilletii ♀ × scalaris ♂) has the pendent inflorescence of the father, and also its red bract leaves, but there are brown spots thereon, as with the mother, and, most important point, the bract leaves are almost as close and as boat-shaped as in V. Barilletii ("Gartenflora," 1890, p. 7, with illustrations). It forms, therefore, to a certain extent, an exception.

15. *Vriesea Kitteliana,* Wittm. (Barilletii ♀ × Saundersii ♂), has the character of the father, viz. the panicled inflorescence. The bearing leaves of the separate spikes are, however, larger and farther apart, which points to the mother. The bract leaves show all grades of transmission forms ("Gartenflora," 1890, p. 326, with illustrations). This also is an exception, as is

16. *Billbergia hybrida,* 'Franz Antoine' (Windii ♀ × Rohani ♂) (*Wiener Illustrirte Garten-Zeitung,* No. 12, 1891, coloured plate).

The crossing of *hybrids* gives very varied results.

Vriesea Kitteliana ♀ × Wittmackiana ♂ yielded from one and the same capsule three plants, which were similar to the father, V. Wittmackiana, in having a simple beautiful red and gold coloured, darkly spotted spike; one, on the other hand, resembled the mother, which carries a red-green coloured panicle. From this second cross there has been no new middle product, but a reversion to the parents has set in ("Gartenflora," 1894, p. 201).

In the following year seedlings from one and the same capsule bloomed again differently (see "Gartenflora," 1895, p. 555). Probably the characters were not yet sufficiently established in the hybrids which served as parents.

17. *Vriesea Petersiana,* Wittm. (guttata ♀ × Barilletii ♂), shows again clearly the influence of the mother in the habit: it has the spotted leaves and the somewhat bowed drooping inflorescence of guttata. It is true that guttata has a quite drooping panicle, but on the other hand our hybrid has from the father, V. Barilletii, the boat-shaped bract leaves and the thick spike-shaped inflorescence ("Gartenflora," 1895, p. 456, with illustrations).

18. *Vriesea Sanderiana,* Kittel (guttata ♀ × Wittmackiana ♂), has also the spotted leaves of the mother, but only a slightly drooping flower-spike; the reddish-white colour of the bract leaves of guttata is transformed into a beautiful carmine-red, as is seen in Duval's Vriesea rex (for V. rex see "Gartenflora," 1895, p. 20), clearly due to the father's influence. The

reversed cross is very striking. Here has guttata had the effect of causing the inflorescence to be entirely pendent.

Compare the three figures, "Gartenflora," 1897, p. 378.

In some cases the influence of the father may indeed affect the leaves also, as in

19. *Billbergia hybrida Hoelscheriana*, Kittel (nutans ♀ × Saundersii ♂), wherein the leaves are dotted more or less with translucent points, as in Saundersii; they have also been somewhat broadened, and are not so narrow as in nutans. The habit is otherwise like the mother's: especially is the inflorescence pendent, while the light blue edge of the petals of nutans is turned into a beautiful indigo blue ("Gartenflora," 1898, p. 286).

Conclusion.—If we now proceed to answer our two questions put up at the beginning of this article we may say:—

1. *The floral parts are usually more influenced by the father, the vegetative parts by the mother.*

2. *The influence of the mother is usually greater.*

But I must remark that M. Léon Duval, of Versailles, holds the opposite opinion to mine. In "Gartenflora," 1895, p. 20, he says that the influence of the *father* is shown mainly in the *habit* of the plant, and that of the mother in the inflorescence.

"If I," says M. Duval, "wish to reduce the volume of a plant, I fertilise the larger with the size smaller; to increase it, I fertilise the smaller with the larger."

Mr. Tropp remarks, supplementary to this, that amongst Orchids it is also thus, but not always.

In my opinion, however, as I have stated above, *the mother has the more influence upon the habit; the father the more upon the inflorescence, at least upon its colour.* It would be interesting to hear the opinion of the Congress hereupon.

PRINCIPLES OF HYBRIDISING HOLDING GOOD IN THE MAJORITY OF CASES.

By Herr Max Leichtlin, Baden-Baden.

1. The female parent gives to the offspring the form and shape of the flowers, also certain qualities.

2. The male parent gives more or less the colouring of the flowers, and if it is richer and freer flowering than the female, this property is transferred to the offspring.

3. Artificially produced offspring give larger flowers than either of their parents.

4. The more distant the habitat of the species intended to hybridise, the more difficult they are to take each other's pollen.

5. The offspring becomes infertile and delicate if the form of the flowers of their parents is widely different in shape and outline.

BREEDING STAPLE FOOD PLANTS.

By WILLET M. HAYS, Professor of Agriculture in the University of Minnesota, U.S.A.

THE vast influence exerted by man in distributing and in improving the important grain, forage, root, vegetable, and fruit crops which sustain man and the domestic animals is rarely dwelt upon, and is really but partially comprehended.

The distribution of these economic plants is by no means complete, and there are doubtless many useful varieties suited to the conditions of numerous localities into which they have not as yet been successfully introduced. Modern improvements in facilities of transport, the greater avidity of growers for useful new things, the more systematic efforts of seedsmen and nurserymen; and the organised efforts of scientific societies, experiment stations, and departments of agriculture, are all aiding in the rapid adjustment of species and varieties to the localities to which they are suited.

The improvement of varieties, likewise, is going on at a more rapid rate than ever before, both through chance discoveries and as the result of systematic effort. Many forms have been brought together which cross in nature, thus resulting in a greater variety of new forms, some of which, happening to be of superior merit, are propagated. Year by year the increasing number of trained horticulturists and farmers develop a keener sense of discerning new and useful accidental forms, which they preserve and propagate, and they yearly make more clearly defined demands upon the seedsmen and nurserymen for plants to fit special conditions. Seed and nursery firms are on the alert to purchase useful varieties from amateurs who produce them, or from persons who make chance discoveries. These firms have entered upon the production of a few of the food plants in a rigidly systematic manner, but they have turned their attention to the flowers more than to the food-producing species. Sugar-Beet breeding is the most prominent object-lesson we have in breeding either plants or animals. The results here should inspire the world with a faith that all useful plants and animals may be scientifically bred so as to add very greatly to the world's wealth. The goal is so great, if the results in Sugar-Beets may be taken as a standard for possible achievements, that the money and time required are but a drop in the bucket in comparison. A dozen of laboratories on Sugar-Beet seed-farms in Europe make riches for the seed growers and dealers, a very profitable business for many sugar factories, good prices for growers of Sugar-Beets, and far cheaper prices for the people of the entire world for their sugar. The principles of practice in the scientific breeding of Sugar-Beets are comparatively few and easily understood, and it seems quite strange that they should not have been heretofore generally applied to the breeding of grain, forage, and fruit crops. One does not need to be a prophet to see in the handwriting upon the wall, that science is soon to make in plant breeding, and

in animal breeding as well, greater achievements than heretofore, because more people with scientific training are devoting themselves to it.

Amateurs have done much to bring forward chance varieties, and more recently the hybridising done by amateurs has been of much use in the important food plants as well as in ornamentals. But the great work of improving our staple field crops and our tree fruits, and even our small fruits and vegetables, has not been generally undertaken with that energy which their exceeding great importance would warrant, and animal breeding is as yet only an amateur art, though in some cases a highly developed art.

The hundreds of millions of dollars of value which would annually accrue from the addition of a single bushel per acre to the average crops of cereal grains, is of such great importance as to justify sufficient experimenting in every country and valley in the world, to secure the best varieties of crops, and to improve them so as to still better suit the respective local conditions.

In the practical plans pursued by the various breeders of plants and of animals, doubtless most of the important elements of the science of breeding are represented. But those principles have not been well collected into a literature, and few men have in their individual knowledge and practice a comprehensive and working knowledge of the general subject, though many have succeeded in their special lines of practice. Some of the broader principles have been wrought out by the breeders of ornamental plants, and yet others by the breeders of Sugar-Beets and other food plants. There are numerous general laws applicable to the breeding of all species of plants and of animals; there are other laws applicable to plants only, and others to animals only; and to each species, and even to each variety, there are special facts, conditions, or necessities in practice which must be recognised.

The subject as a whole is a fertile soil composed in the main of virgin fields; and while not so difficult to cultivate, it will doubtless endure the cropping of many who will here toil in science and in industry. While the furtherance of the study of the fundamental science of breeding is of the first importance, so much can be done with the present development of knowledge that plant breeders need no longer so strongly feel the paralysis of ignorance.

All intelligent effort, long continued, has brought such wonderful results in the breeding of flowers that we need not lack faith in improving our food plants.

To illustrate the widely different methods practised in the breeding of food plants, a few practical illustrations are in order:—

1. Sugar-Beets have been subjected to laboratory methods: the fullest records have been made, pedigrees have been studied, and used even more rigidly than in animal breeding, and many special points and principles have been incidentally worked out.

2. Indian Corn (Maize), on the other hand, being a large plant, with the ear large, and always taken in the hand and its size and quality noted by the grower, has been profoundly improved by the American farmers. They have greatly increased the yield and improved the quality of dent corn in the original home of dent corn, the Southern States; and they

have bred it so as to already move the north border of the dent corn belt one hundred miles or more further northward. Many varieties have been bred so as to suit local conditions. Here, as in the breeding of Sugar-Beets, the selection is from among immense numbers. Corn and Sugar-Beets seem to have been peculiarly amenable to improvement; but similar careful and extensive breeding of other crops might prove equally effective with other open fertilised species—it would indeed be surprising were it to turn out otherwise.

3. Wheat has been very materially improved by Sheriff, Vilmorin, Rimpau, and others, by selection much less extensive than that with Indian Corn or Sugar-Beets; and Garton Brothers have produced great changes in numerous species and varieties of field crops by extensive crossing, followed by selection.

Burbank, in California, has produced new values in many fruits and flowers, and his faith in extensive selection seems to be increasing. The value of using immense numbers is rarely well understood; but here lies one of the important, if not the most important, fact or principle of practice. There are difficulties to be overcome, both of a technical nature as relates to the plant, and of a business nature as relates to the remuneration for the extensive labours necessary in the breeding of Wheat, Oats, Timothy, Red Clover, Apples, and other staple crops; but these difficulties are no more serious than were those overcome by Vilmorin and others in the breeding of Sugar-Beets, and modern genius should be equal to the task. The work is often somewhat difficult and very expensive.

I have myself superintended the expenditure of some thousands of dollars by the State of Minnesota in breeding from our staple varieties of Wheat new sorts which, it is hoped, will raise the low average yield. At the end of ten years a few varieties are in hand which promise to increase the yield of Wheat probably five to ten per cent. This increase, when applied to millions of bushels, makes the cost of breeding the new varieties appear relatively very small. And each new variety which yields more, at once serves as a foundation for further improvements whence still better varieties may result some years hence.

In the following table are given the yields and other data regarding the best eight chosen from among thirty-one varieties originated eight years ago. These varieties were originated from Wheats generally grown in the States, and are classed as Red Fife and Blue Stem, both summer Wheats. In the table are placed also the records of three of the original stocks from which the new varieties have been evolved. The eight new ones have proved, on numerous trials, to be superior to the parent varieties; but most of the rest of the thirty-one new ones have been discarded.

Among a lot of other varieties produced by cross-breeding some yielded more and some less than the original parent varieties.

The second table shows the increase or decrease in yield secured from each of thirteen new varieties, as compared in two to ten field tests with the respective parent varieties. It will be observed that one wheat, Minnesota No. 284, yielded 5·3 bushels less than its parent, while Minnesota No. 169 yielded an average of six bushels more than its parent.

In our experiments, so far, an average of ten new varieties are

Wheats. Eight Best of Thirty-one Selected from 1,892 Mother Plants.

Names of mother varieties	Names of new varieties	Yield per acre, average of 6 trials	Grade, average of 6 trials	Weight per bushel, average of 5 trials	Rust, average of 4 trials	Gluten test, average of 4 trials: Quality	Gluten test: Per cent. dry	Baker's sponge test, average of 4 trials. Volume of rise: First rise	Second rise	Rise from each gr. gluten: Average first and second rise	Rise from each gr. gluten: Second rise
Power's Fife	Minn. No. 149	25·6	91·3	58·8	18·0	90	13·5	1,065	738	66·8	54·5
Glyndon 818	„ 155	25·5	90·0	58·7	11·5	88	13·5	1,075	663	75·1	70·0
„ 753	„ 157	25·6	83·6	58·7	11·5	88	13·9	1,013	688	61·9	49·8
„ 811	„ 163	27·1	87·3	57·7	11·0	87	13·8	1,075	719	65·6	52·2
„ 761	„ 167	26·2	70·0	58·4	10·0	81	12·7	988	713	68·6	58·4
Haynes's Blue Stem	„ 169	28·5	86·3	57·8	6·0	80	12·5	988	688	68·5	59·1
Risting's Fife	„ 171	26·3	86·1	57·9	10·0	80	13·1	1,045	723	71·8	56·9
McKendry's Fife	„ 181	25·9	86·6	57·7	11·0	91	12·5	963	750	71·2	62·0
Standard old varieties											
Haynes's Blue Stem 51		24·6	87·0	57·8	6·2	85	13·4	925	731	59·5	54·7
Power's Fife		23·6	86·0	58·5	12·2	86	14·0	938	706	58·9	50·2
Bolton's Blue Stem		26·5	90·0	58·0	9·5	84	13·2	1,063	700	69·3	54·9

New Varieties compared with their Parents; +Gains, −Losses.

Minn. Nos. of parents	Minnesota Nos. of new varieties	Minn. No. 161	Minn. No. 169	Minn. No. 283	Minn. No. 149	Minn. No. 276	Minn. No. 171	Minn. No. 292	Minn. No. 293	Minn. No. 287	Minn. No. 163	Minn. No. 181	Minn. No. 284	Minn. No. 288
	No. of Trials Averaged	4	8	2	10	3	2	2	2	2	3	2	2	2
	Names of parents													
51	Haynes's Blue Stem	−·1	+2·8	−1·6	—	—	—	—	—	—	—	—	—	—
66	Power's Fife	—	—	—	+1·5	−1·0	—	—	—	—	—	—	—	—
476	Risting's Fife	—	—	—	—	—	−·7	+1·2	−4·1	—	—	—	—	—
476	McKissick's Fife	—	—	—	—	—	—	—	—	−2·1	—	—	—	—
168	Glyndon 811	—	—	—	—	—	—	—	—	—	+2·3	—	—	—
477	McKendry's Fife	—	—	—	—	—	—	—	—	—	—	+2·0	−5·3	+1·8
	Gains at University Farm, Only 4 trials	—	+6·0	—	+4·2	—	—	—	—	—	—	—	—	—

produced to secure one superior one. A prominent Potato breeder has said that not more than one new variety in two thousand proved sufficiently valuable to become a commercial variety; yet the breeding of Potatos has added sufficient to the value of that crop to pay for the required labour a thousand, if not a million, times over.

The above-mentioned experiments in Wheat breeding are reported upon in full in Bulletin No. 62 of the Minnesota Experiment Station, and a number of copies are held in reserve for exchange for writings on plant and animal breeding.

Steps in Varietal Evolution.

Many amateur hybridisers make a mistake in thinking that the hybrid is the end sought, the difficult feat to be performed, the result which brings value and creditable mention. Only when that number of hybrids is produced that a really useful or attractive form is secured and given to the world are the results valuable from an economic or artistic standpoint; and only when the method is so recorded as to be a guide for future work are the results valuable from a scientific standpoint. In the case of many crosses, the individual plants, of hybrids between dissimilar species, mostly revert downward in yield, or in other intrinsic qualities. It is only the exceptional plant which varies strongly in the desired directions. Extensive selection must therefore accompany crossing to get the highest possible results. The selection should begin with the varieties to be crossed. How little we know as to the average results of the crosses between any two species or varieties, and how little are we able to predict how many individual plants of each cross we must throw away for each useful one we shall find under rigid selection! There would seem to be no end to this portion of botanical research.

Selection of the parent plant within the variety is ofttimes very important. In Wheat, for example, there is great variation in the strength and in the prepotency of the individual plant, and it is important that good plants be chosen and that the power of these be tried to see that they are potent in the production of good plants; in other words we must raise a generation of plants from each parent plant, and compare these second generations or broods that we may know the relative values of each of the mother or father plants as parental stocks. We must measure the breeding value of the parent plants by judging or comparing their produce. The breeder of pigs likes to have the male, which is to head his herd, show his pedigree on his back; he also requires a good written pedigree, but the value of the sire or dam is still better judged by seeing a large number of his or her progeny.

Since the labour of developing hybrids, when fully carried out, often is very great, the probabilities of useful results from crosses should, where practicable, be increased by carefully selecting the foundation or parental individuals. Since variation may occur all along the line, where it is practicable, the best flower should be chosen on the best part of the best plant.

Hybridising, in breaking up the centripetal force of heredity and by letting loose the centrifugal forces of past generations—which forces, acting

alone or in combination, express themselves as old or newly compounded forms or qualities—often gives the best materials for the plant breeder to work upon. Whether the cross is radical or mild, the centrifugal force seems to reach its climax in a few generations; but the tendency to vary ofttimes continues for many generations, differing with the individual plant in close fertilised species, and with pairs of plants mated in open or insect fertilised species, or in case of artificial fertilisation.

The practical point is that it is often wise to give free rein to variation for at least a few generations. Not all the resulting plants need be kept, but it is wise to keep very many strong ones or those having special characteristics. Largeness of numbers in the progeny requires system in the selection, that the intrinsic qualities may be sought after in the most effective manner, and that the labour be not wasted upon many useless forms. The intrinsic or special qualities should first be sought, and then the stocks should be bred to uniformity of type afterwards. Much stress has been laid upon having the forms uniform in all their characters—in matters of appearance, if you please—as well as in matters pertaining to special values. No doubt the longer time required to fix several characters makes the variety more stable; but if the greater labour be nearly all directed for the longer time to the intrinsic or special qualities sought, no doubt time and labour would be expended to more purpose. For practical purposes many new hybrids produced from seeds are fixed in type by rigid selection for only three to six generations; and the stronger growth or fruiting character of most food-producing plants may be fixed in a comparatively short time, whether open or close fertilised, while in the case of plants propagated by division they are at once sufficiently well fixed in character for practical uses. In such cases as the open-fertilised Sugar-Beets, where the seeds are raised in one place and sold in many lands, the longer time spent in fixing characters, the attention to fixing the permanency of form of leaf and other non-intrinsic qualities, doubtless has much weight; but in the case of grains, forage crops, &c., bred in the general locality in which they are to be used, the stability of the characteristics of large yield, good quality, and hardiness is usually provided for by rigid selection during only a short term of years. The American farmer has wisely sought the large sound ears of corn, caring little whether the cobs were all of one colour or the leaves of similar form.

Since selection affects crops to which, in the aggregate, are attached immense value, the selection should be from among such large numbers that the greatest increase in yields and qualities will surely result. M. Vilmorin and other breeders of Sugar-Beets have fully recognised this most important principle. Here, quality of sugar per acre, together with its availability, are the requisites, and these experimenters early took a direct road for results. They dealt first with varieties, securing the best; then they sought the best roots; and then they tested the capabilities of each mother root in the ability of its seeds to produce roots with high yield of sugar and high purity of juice—in other words, its prepotency. With the best roots from the best mother plants, the process was repeated indefinitely, each season seeing a gain of one-fourth to one-half per cent. of sugar, and little, if any, lessening of the gross yield per acre of the crop

of Beets. The past and future value of this work to the world is represented by vast sums of money.

Increasing superior stocks, giving them trials beside standard sorts, choosing out only those which are superior, and then increasing them for the public, is not only an expensive operation, but one requiring much care. In this many of our breeders of new things have failed, because, as among inventors, business ability has not in all cases been coupled with the ability to produce new things. The public has so little confidence in new things, because they have been asked to pay long prices for the privilege of experimenting with so many newly originated varieties sent out before their values were fully determined experimentally. Far more of this experimenting should be done on the grounds of the introducers, and on the grounds of such establishments as public experiment stations, where trained experts are employed for the work. This is especially important with field crops. While in the case of the ornamental plants, or of fruits and some vegetables, it is quite practicable for each grower to try a few plants of many varieties in a very inexpensive way, it is not so with grain and forage crops. While the crucial test for new things is always the test given by the practical growers, yet the plat testing of new varieties, as of Wheat, Sugar-Beets, Field Peas, or of Timothy, could easily be made at a sufficient number of places, such as experiment farms, so that the growers could in most cases rely on the formal plat tests of the experimenters. These tests should always be done in such a manner as to imitate field conditions; the soil should be uniform and the labour should be performed in an expert manner. This is expensive work that can properly be undertaken by the Government for the whole people.

THE FUTURE OF PLANT BREEDING.

The literature on plant breeding is much scattered. There is no recently published bibliography; much that has been put into print is wrong; and that faith which people should have in increasing the value of crops through heredity is not strongly built up or increased on reading much that has been printed. Charles Darwin still remains the great collator and interpreter, but his thoughts centred most on clearing up the larger scientific question of Evolution; but between the lines there is inspiration for those who add to the world's wealth by breeding animals and plants. Darwin had the spirit for gaining experimental knowledge of heredity by actually experimenting in a large way; but time has been necessary for his followers to earnestly take this work up in detail. Prof. Hugo de Vries and others who are looking systematically for the nature of changes, the laws of breeding, the best means of producing important results, are engaged in a most important work. Against the great difficulties with which the work is beset, is the vast scientific and economic utility of any useful discoveries which may result.

This work requires not only much time, but the expenditure of money. A few things done well, with conditions under control, and records and specimens properly kept, should be the motto of the experimenter. Persons who are making new races or varieties have done far too little in recording methods and results. They have usually found their first

start by accidentally discovering a new plant. They know only how the chance seedling was further selected and made more useful. Those who have produced crosses often have no carefully-made notes which, if kept, would be a guide in future experiments. In the Northern part of the United States, for example, numerous new seedling Apples have been originated. It may be that some one cross has resulted in the production of most of those. Were it found true that a cross between the Duchess and Roman Stem Apples had produced a number of good and hardy varieties, and that from a like number of crosses between other varieties nearly all had failed in hardiness or in other particulars, we could interpret the results as indicating that energies would best be spent in crossing the two varieties mentioned, and in testing their resulting seedlings. There is a large amount of this breeding going on. The notes could be simply and easily kept; and with careful records the work is more pleasureable, and the best plants are more certain to be selected from among the many crossbreds which must be produced to get a few superior ones.

The idea that there are secrets in variéty production is not worthy of the age in which we live, and it does not prevail in the minds of the leading men interested in the breeding of either plants or animals. Men have sometimes mistaken their artistic skill for secret knowledge—"science for which no language has yet been developed." Under investigation this knowledge or art often proves to be founded upon the chance discovery or selection of a very superior plant or animal, which the grower has been wise enough to multiply. "The secret knowledge is being aware that the pretending wise breeder is claiming to know something when he does not."

Important subjects eventually reach the school-room. The pedagogics of plant and animal breeding is becoming a lusty infant. Through our schools of agriculture much can be taught. Since breeding is mainly an art, the practical work will always predominate over the scientific in the properly developed course of study. Since experiments and practice in animal breeding are not usually practicable in a school, both because of the long series of years needed, and especially on account of the expense of even such small and rapidly reproducing animals as fowls, most of the practice work, and most of the demonstration experiments, must be confined to plant breeding. While the teacher needs experience, he also needs access to the literature. This can only be reached with great effort, since the valuable writings are much scattered. The collections of agricultural books in the schools of agriculture, in the offices of agricultural newspapers, or in general libraries, are, as a rule, in poor condition. The articles on each subject, besides being in fragments in various publications, are not properly catalogued. People have as yet hardly awakened to the fact that agricultural education and experimentation are very expensive, yet, even at a high cost, are very profitable. And the more nearly the provision of money is adequate, the better are the proportionate results, whether the money is spent in educating boys to be farmers or technical agricultural scientists, or in the conducting of original research. The breeding of plants can properly be made a minor subject in many secondary, higher, and post-graduate schools.

The more numerous classes of plant breeders are the gardeners and

farmers, though as a rule they only select in a crude, yet sometimes very effective manner. Next come the amateurs, who choose a special line, and often carry it out, in a more or less effective manner, to a very successful issue. These men have been especially numerous in England, where amateur science has been fashionable among professional and even among business men, and gentlemen retired from business. Third may be placed the commercial seedsmen who, securing the stock of good varieties from the amateur, the gardener, or the farmer, improve them from year to year, using their carefully selected stock of one year, for growing fields of the seeds for the market the next. The attention of professional scientifically trained officials is being turned to the breeding of plants, and to the study of the breeding of plants and animals. Hybridising and plant improvement have been but little entered upon by women, yet there is room for them here as in many other lines requiring manual skill, patience, and interesting study. The general results to the public of improvements in plants and animals cannot easily be counted, since the results are accumulative, the work of one year serving as a foundation for better results the next.

Each locality has its peculiar needs from the plant breeder. In Minnesota the low yield of Wheat on our rich lands calls loudly for varieties which will add 20 or even 50 per cent. to the crops of grain. We also need a variety of Red Clover which will stand our severest winters as well as the common variety stands our best winters.

In Dakota a *Bromus inermis* is needed, which will still better resist drought than the common variety of this species newly introduced there on account of its drought-resisting power. In England varieties of Wheat, Oats, and Barley are needed, which, under the heavy fertilising, will not lodge, but will stand erect, making it practicable to use the self-binder, and thereby save expensive labour. On the moorlands of Western Europe are needed varieties of the common forage and grain crops, especially bred to thrive on peaty soils. Every locality has its peculiar needs, and in the aggregate these needs represent enormous values. Plant breeding may yet find a large place in agricultural improvement, taking its place beside chemistry and physics. The importance and the difficulty of the work make it worthy of the energies of the best minds.

ON THE USE OF TRANSPARENT PARCHMENT PAPER BAGS FOR ARTIFICIAL FERTILISATION.

By Professor Hugo de Vries, Amsterdam University.

Since the year 1893 I have used for my experiments in artificial fertilisation in the open air caps and bags made of transparent parchment paper, such as are used largely in commerce for fruit and Grape culture.

When it is desired to conduct experiments in selection with artificial pollination this must be effected in gardens, and therefore in the open air, because prior to the selection it is not known from which individuals the seed will have to be gathered; and after the selection it is, as a rule, too late to transplant the seed-bearers in order to transfer them indoors or into greenhouses. I therefore do all my fertilisation in the open.

In order, therefore, to protect the flowers concerned from insects' visits, I cover them with bags, which, according to my experience, are rarely damaged; and both in sunny weather, as well as in wet and windy, keep in excellent condition.

In wine culture, both on the Rhine and the Moselle, as well as elsewhere, these bags are used for the purpose of protecting the Grapes during their growth from wasps, vermin, and birds, fostering their growth and improving the quality.

They are made of thin transparent parchment paper, saturated with some fatty substance, which prevents the passage of moisture, but permits that of light and sunshine. There is developed in these glass-like covers a greater and more lasting warmth, which consequently helps the growth of the fruits and Grapes, and presumably increases their sugar contents.

Shortly after the flowering, when the berries and fruit have set, the caps and bags are placed over them, folded above around the fruit stalk, and bound either with a metallic clip or with string. They last for several years.

These parchment paper bags are made in the bag factory of Mr. P. J. Schmitz, in Düsseldorf, of any required size. For fertilisation of *Papaver somniferum* I use, for instance, bags measuring 15 × 20 centimetres. For covering the flower stems of *Œnothera Lamarckiana* I need bags 20 × 40 cm., or even larger.

They are also made with perforations which afford more air, and on account of the smallness of the holes might also be used in fertilising work, though I have made no experiments with them so far.

My experience with these bags is fairly extensive. With *Papaver somniferum* I have for five years used such covers for some fifty to 100 flowers each year, fertilising partly with own pollen and partly with foreign pollen. With *Œnothera Lamarckiana* and related species and varieties I have used annually some hundreds—in 1898, indeed, about 600 individuals were covered. Furthermore, with the aid of such bags I have artificially fertilised *Antirrhinum majus*, *Chelidonium majus*, *Linaria*

vulgaris, *Lychnis vespertina* and *L. diurna*, *Papaver nudicaule* and *P. Rhœas*, *Silene Armeria* and *S. noctiflora*, and several other species and genera.

In many cases it is certainly more convenient to carry out the fertilisations in cages. Formerly I used small removable cages of wire gauze or tiffany, and now I have in my experimental garden a still larger cage made of fine wire gauze. But insects now and again can find their way in, either as eggs or larvæ, existing on the trial plants or in the soil in the pots. I use, therefore, cages only in such cases when chance insect visits would not be detrimental to the results of the experiments. For fine work, however, I use exclusively these paper bags.

In wet weather the parchment becomes damp and limp; it does not, however, tear. No water penetrates, and frequently after the rain it is found that considerable quantities of water have accumulated in the folds of the bags. Even in windy, stormy weather they are not torn unless sharp-pointed stakes are used with the plants, upon which the bags become impaled. Even in that case, however, the hole, which may result in weather at once windy and wet, and through which the stick protrudes, is practically stopped thereby, and hence even in this unfavourable case no insect would, as a rule, find entry.

The bags have furthermore the advantage that the particulars of the experiments concerned can be written upon them either with the so-called Indian nib or with pencil.

Solitary flowers, which only need fertilising once, such as Poppies, form evidently the most convenient cases to handle. With *Antirrhinum* and *Œnothera*, I envelop the whole flowering stem in a bag and open this every two or three days in order to fertilise the fresh flowers or to castrate the new buds. Each plant requires then usually two or three weeks before a sufficient quantity of seed is fertilised. But the frequent opening and closing of the bags does not damage them.

To actual risks the flowers in these bags are only exceptionally exposed. For green leaves too little light penetrates, and thus they fade and become yellow; but only if the experiments be of long duration. Fraught with greater danger is the heat on hot August days. In the full blaze of the sun, the air in the bag can become so warm that the young half-grown flower buds drop off, and are thus lost for the continuance of the experiment. This often happens with *Œnothera Lamarckiana*. Or the flower buds concerned may die from drought, as occurs with *Antirrhinum majus*. Further, it appears that great heat is detrimental to the formation of the pollen, as I found under such circumstances that for several days in succession the young flowers of certain varieties of *Œnothera Lamarckiana* were without any pollen or had very little.

It is possible that in such cases the perforated bags would suit better; in rainy weather, however, they would plainly be less secure.

I close my bags usually, not with metal clips, but with coarse string; it is, however, not merely a question of excluding bees, humblebees, and flies, but also to guard against the entry of earwigs, which find shelter in their folds, and by devouring the pollen can often prove very detrimental in cases of artificial self-pollination.

The bags when once used can be used again repeatedly, so far, at least, as the possibility of adherent pollen to the inner side carries no risk with it. I utilise the bags also for collecting such kinds of seed as might easily be blown away. To this end the flower stems concerned are simply enveloped in the bags before the seed is ripe. Later on the entire bunch or stem is cut away with the bag upon it. In this way, for instance, I have almost always harvested the seed of my fasciated races of *Compositæ*, *Taraxacum officinale*, *Aster Tripolium*, *Crepis biennis*, and *Picris hieracioides*. The gathering takes thus but little time, and there is practically no loss to speak of.

In view of the experiences above described, I recommend all who have to carry out crossing or self-pollination experiments in the open to cover the flowers of their trial plants with bags of parchment paper.*

* Thanks to the kind co-operation of the manufacturer, Mr. P. J. Schmitz, in Düsseldorf, specimens of these parchment paper bags of all sizes were exhibited at Chiswick, and placed at the disposal of the visitors.

HYBRID CINERARIAS.

By R. Irwin Lynch, F.R.H.S., Botanic Gardens, Cambridge.

In this paper I give, as requested, an account of my own hybrids, adding, however, some remarks upon hybrids by Mr. W. J. James, as desired by him. All the crossing I have done was suggested by an interesting and stirring discussion in *Nature* some four years ago, between Sir William Dyer and Mr. William Bateson, upon the origin of the florists' Cineraria; but it should be observed that many of the crosses were made without any expected bearing upon that question. As might be expected, the time at my disposal for the particular work has been altogether insufficient for the record of any considerable detail, and I regret therefore that all the scientific results that were possible cannot be forthcoming. I use the word "hybrid" in speaking of plants and "cross" with reference to cross-pollination.

The wild plants I have worked with are:

Senecio cruentus, *Hort. Kew.*, non D.C.
——— Heritieri, *D.C.* (Cineraria lanata, *L'Hérit.*)
——— multiflorus, *D.C.*
——— Tussilaginis, *Less.*

and with these in several instances, the florists' Cineraria has been combined.

It is important to note that the above *cruentus*, familiarly known as "Kew cruentus," can only be called *cruentus* by taking the too broad view to which botanists are sometimes liable. There are several important differences, inasmuch that I find it a very invariable plant, only kept through the winter with great difficulty, comparatively colourless in its nature, and so poor in attractive qualities that my judgment revolts against the idea that any florist ever took it in hand to improve it. No florists' flower ever originated from a plant which had not already much to recommend it. With this plant, however, work has been done, and also much written, perhaps, upon the assumption, to which I entirely demur, that it is at all a *cruentus* in this connection. It is quite an unfair assumption, I believe, to both sides of the question, as to the origin of the florists' Cineraria, and I may perhaps be allowed to make a friendly protest against the disregard of the botanist for differences which are great to the horticulturist. Very valuable is the work of the botanist with books and dried plants, but I deplore the practice of merging under one name and without distinction plants which are absolutely different and distinct, and actually *known* not to be identical. If attention is drawn to these differences they are admitted to be quite evident, but they are said not to be important. Now here lies, I am sure, a most gigantic error. No botanist who does not work in the garden with living plants can appraise the degree of importance which attaches to a difference he can recognise, and while I quite appreciate and fully understand the arguments and difficulties of the other side, I do venture to

suggest that some remark should be made, or sign given, in all botanical writings, without exception, when plants are put together without being considered identical. All the plants above enumerated, understanding of course a good *cruentus*, I believe to be in the florists' Cineraria, with the exception, however, of *Senecio multiflorus*, and this I am sure is clearly not in it. To the Cineraria, however, I shall return, and shall, I feel sure, justify my contention.

Some general observations, based upon these crosses, may be made from a botanical point of view, and the chief, perhaps, is that while any two species cross with facility, not one can set seed with pollen from the same individual plant. A practically barren hybrid is the result preferred by nature, rather than continuation of the pure species without crossing. Sterility, in greater or less degree, results from crossing the more widely differing kinds; but I am not sure that it cannot always be traced to *Heritieri*. If *Heritieri* is crossed with either of the others it results in greater or less sterility, and so the Cineraria with others; but I believe that *Heritieri* in the florists' Cineraria may here be charged with the result. The Cineraria itself is not very fertile. Hybridism, however, sometimes increases fertility; as, for instance, in both hybrids between *cruentus*, *Hort. Kew.*, and *Tussilaginis*. These hybrids, if several plants are together, produce quantities of seed by insect agency, which comes up on the ground beneath, like Cress. This could not be said of either parent. It would be interesting to know how these perfectly distinct species are situated in Teneriffe; whether they are kept apart by natural conditions or what happens when they cross, as inevitably they must do, of necessity, according to experience under glass, if they come within reach of one another. With such a case as this in mind, it is exceedingly difficult to understand how the origin of species could help happening sometimes through hybridisation. Returning for a moment to sterility, I may remark that it appears to vary with the same cross and under different conditions, so that the question is raised, among others, whether it is not largely due sometimes to the new vigour induced by the cross. Whether this is so or not is worth investigation; but, for myself, I could find no time to follow the numerous trails of this kind that cross one's track. A point of great interest shown by some of these hybrids, and one bearing on the origin of the Cineraria, is that the shrubby habit of *Heritieri* is lost by crossing a very few times. It was almost a contention in the discussion to which I have referred that *Heritieri*, being shrubby, could not form part of the Cineraria, which shows no trace of that feature. It had practically disappeared in some of the hybrids named below, and its absence from the Cineraria is not, I believe, to be regarded as evidence that *Heritieri* is not in the parentage. There is, however, very strong evidence, to my mind, of *Heritieri* parentage in the ringed arrangement of colour so familiar in the florists' Cineraria. I believe, in fact, that it came from no other source. I know of no other allied wild species in which it occurs, and though I have had other variations, that particular arrangement of colour has appeared in not one of the large number of seedlings I have raised, save by the known influence of *Heritieri*.

A detailed record of the individual plants from each cross would have

been interesting, but I can refer only in general terms to some of the hybrids. *Heritieri* × *cruentus* answered much, I believe, to the reverse cross made by Mr. James, and described by Mr. Rolfe in the *Gardeners' Chronicle* of August 6, 1898, p. 101; but habit was less governed by *cruentus*, judging from the description referred to. The plants were tall, very floriferous, with small flower-heads, the ray varying in colour from white to rosy purple. In the mass these plants were exceedingly effective,

FIG. 106.—SENECIO CRUENTUS ♀ × S. TUSSILAGINIS.

and Mr. Burbidge, I believe, proposed that they should be called summer Asters. *Heritieri* × *multiflorus* had much the habit of *multiflorus*, with flowers intermediate. *Cruentus* × *Tussilaginis* and *Tussilaginis* × *cruentus* were very much alike, and certain plants, indeed, came very near what an early Cineraria might have been, but wanting, at least, descent from a better *cruentus*. *Multiflorus* × *cruentus* grew tall with broad, loose heads, and though showing variation, was, perhaps, fairly inter-

mediate. *Multiflorus* × *Heritieri* was very tall and coarse—less interesting perhaps than other of the hybrids. *Multiflorus* × *Tussilaginis* was perhaps very nearly intermediate, but the fine features of the parents were quite destroyed. Coming now to hybrids or part hybrids in which the florists' Cineraria took part, a few are worth mention. *Heritieri* × *Cineraria* is perhaps valuable in some of its colour forms. The flowers are large, brilliantly coloured, are produced over a long season, and the habit of the plant is much more graceful than that of the Cineraria. It is perfectly perennial, and favourite forms are easily increased by cuttings. *Multiflorus* × *Cineraria* was figured in the *Garden*, July 17, 1898, and is the cross known as *Lynchi*. It is decidedly ornamental, and has a good habit—less close than that of the Cineraria. The reverse cross *Cineraria* × *multiflorus* is comparatively a coarse plant. It had a curious tendency for some of the rays to be spotted. *Tussilaginis* × *Cineraria* and *Tussilaginis* var. ? × *Cineraria* gave very handsome decorative plants; but the flowers were large, and since the small-flowered hybrids of the Cineraria alone appear to meet the popular taste, I have thought them hardly worth space. One of the best crosses I have made, from a garden point of view, made before at Kew, however, is *Cineraria* × *cruentus*, which produced one of the finest specimens I have ever seen. The following is a list of nearly, if not all, the hybrids obtained, and it may be noted that here, and throughout this paper, the female parent is placed first:—

cruentus × Tussilaginis.
(cruentus × Heritieri) × Cineraria.
Heritieri × cruentus.
Heritieri × multiflorus.
(Heritieri × multiflorus) × (multiflorus × Heritieri).
Heritieri × Cineraria.
(Heritieri × Cineraria) × Cineraria.
(Heritieri × cruentus) × Cineraria.
(Heritieri × Cineraria) × (multiflorus × Cineraria).
multiflorus × cruentus.
multiflorus × Heritieri.
multiflorus × Tussilaginis.
(multiflorus × cruentus) × (multiflorus × Heritieri).
(multiflorus × cruentus) × Heritieri.
multiflorus × Cineraria.
(multiflorus × cruentus) × Cineraria.
(multiflorus × Heritieri) × (Cineraria × cruentus).
Tussilaginis × cruentus.
Tussilaginis × Cineraria.
—— var. ? × Cineraria.
Cineraria × cruentus.
Cineraria × multiflorus.
(Cineraria × cruentus) × Cineraria.
(Cineraria × cruentus) × (multiflorus × Heritieri).

The Cineraria was strongly marked in all the above crosses in which it was used.

The modern form of the florist's Cineraria has not been approached so nearly as I am sure it yet will be, though without a better *cruentus*,

which at least resembles the *cruentus* of Drummond, who wrote in 1827, we shall not, I fear, attain a very near result. How poor our *cruentus* is may be shown by my *Tussilaginis* × *cruentus*, which ought to be *Cineraria Waterhousiana* of Paxton's "Magazine of Botany," vol. iv. t. 219, which it does not even resemble. But some success certainly has been obtained by crosses not mine, and by one of my hybrids, which is much more like the Cineraria than either of its parents. This is *cruentus* × *Tussilaginis*, and it shows a big jump from *cruentus* in the direction of the florists' Cineraria, as shown in fig. 106. The habit of *cruentus* is there, as required, but the inflorescence is not composed of a multitude of tiny flower-heads, but has a smaller number of Cineraria-like flower-heads, quite respectable in size. I have combined this with *Heritieri* for next year's results, and if I can only give time and find space there is every hope of a success parallel to the success one would have with a good *cruentus*. The Cineraria I believe to be a hybrid, because it has the reduced fertility of a hybrid, because it has a mode of colouration foreign to the kind of plant from which no doubt it obtained its habit, because it has flower-heads which to me suggest *Tussilaginis*, and, I may add now, because of the big jump to which I have referred. Much reliance may be placed upon the intuition of a grower like Mr. James, who believes that the Cineraria must have a mixed parentage. There is no reason, indeed, why not, from what we well know, for instance, of the Tuberous Begonias; and it is very likely from the facility with which these plants hybridise. My judgment is based entirely upon the plants themselves, as they stand, and I rely nothing upon records or statements of any kind. I am still anxious to know more completely what may be wild in the Canaries, because I am sure there must be some original *cruentus* worth the first notice of the cultivators. Drummond speaks of his *cruentus* as having great beauty and variety in the flowers: he refers to it as sporting greatly from seeds, and, from what he says, it may be inferred that any favourite form could be preserved through the winter without any great difficulty. No *cruentus* I have seen answers to this description, though *cruentus* we have raised from Mr. Thompson, of Ipswich, is something of an approach to it. This certainly had never crossed with the Cineraria, though supposed two or three years ago to have done so. It is possible that Drummond's plant was an improved one; but even if it was it came from some wild original that would not be thrown away, by any ordinary person, immediately after flowering.

The hybrids raised by Mr. James, to which I have to refer, are all from *Senecio cruentus*, fertilised by pollen from *S. Heritieri*, and a full account was given of them by Mr. Rolfe in the *Gardeners' Chronicle* of August 6, 1898, p. 101. This is the reverse or reciprocal of one of my own crosses. In this cross Mr. Rolfe believes that the *Cineraria hybrida* of Wildenow ("Enum. Pl. Hort. Berol.," p. 893) has been re-obtained. Five plants were first raised, and by crossing these a large batch resulted almost sufficient to fill one house. This to me is interesting, because the hybrids of the reciprocal cross above referred to, in my hands, were very sterile. There is much interest in the fact that the progeny of Mr. James's cross could be classified according to habit, those most resembling

cruentus being placed at one end of the house, and those most like *Heritieri* at the other. Its bearing upon the question of the origin of the florists' Cineraria will be seen from what I have said. We do not always obtain the same thing from a given cross. When, for instance, I made Begonia crosses, some years ago, I found that I did not obtain a passable *B. weltoniensis* from the cross by which Colonel T. Clarke obtained it. Cineraria hybrids show, I think, that hybridising induces variation quite apart from the modifying influence of one parent upon the other, or commingling of their features. Variation surely might so happen in a state of nature.

P.S.—The prominence of a postscript I am glad to give to information, which is important from a purely scientific, as well as from the Cineraria point of view, given me by Mr. James at the Hybrid Conference. Of his hybrid, *cruentus* × *Heritieri*, he says that the plants most like *cruentus* bear seed comparatively freely, while those most like *Heritieri* are comparatively sterile. It gives a physiological reason why, if the Cineraria was originally obtained by crossing with *Heritieri*, there should now be little evidence of that species. That the ringed arrangement of colour came from *Heritieri* I am still as certain, because it is an important feature keenly preserved by the florist.

CREATION OF AN IMPROVED VARIETY OF CROCUS SATIVUS.

By Monsieur Paul Chappellier.

In addition to the question of improvements in culture, there is another which is of interest, although it hardly comes within the province of the small Saffron-grower, it is that of the improvement of the species of Saffron itself.

There have been created, especially in these later times, and there are still created every day, innumerable varieties of all useful or decorative plants, wheat, cereals, beetroot, potatos, pears, apples, roses, dahlias, chrysanthemums, &c. As for the Saffron, there is only known a single and unique species; for ages it has not produced a single variety.

This question has occupied me much, and although, so far, I have only arrived at a half result, I think it may be of service if I explain, with some details, what I have done in this direction. Those who might desire to follow me in this line of investigation may find in these notes some useful indications, if even they only serve to prevent running upon the rocks which I have encountered more than once.

Since 1844 this idea has occupied me. I commenced by importing a number of bulbs from the several countries in which this industry is still carried on: Carpentras, Naples, Athens, Austria, Hungary, and Spain especially. Later I have been able to obtain some from Anatolia, Cashmere, and China.

The appearance of these bulbs differs appreciably from ours; a variety could easily be believed in, and the beauty of the flowers of some among them on their first blooming seemed to justify this hope, but it was nothing—the superiority diminished in the following seasons and disappeared at the end of a few years. The different appearance was due without doubt to the transitory influence of a cultivation and a climate differing from ours.

In default of an existing variety, it was necessary to devote oneself to the creation of one. The means is known—sowing and selection.

Unfortunately, the Saffron yields no seed—at least so it has been always believed. I had, however, heard it declared that a capsule had been gathered formerly (at Eserennes), and furthermore the organs which should co-operate in the fecundation and fructification are so well developed and formed! stamens, stigmas, pollen, and ovary.

Desiring to be clear about this, I advertised about 1850 that I would pay a good price for seed—five francs each for the first. Induced by this offer, the Saffron-growers set to work at the harvesting time, and from 1850 to 1853 they found and brought me a certain number of seeds. The fact being a rarity, I reported it in 1853 at the local meeting at Orleans.

Twenty years later, about 1873, I again roused the attention of growers by the offer of money prizes—and they brought me once again a certain quantity of capsules.

Of the seeds only a small number are fertile, and the plants which

they yield resemble absolutely the parents; no variation whatever. Can this fixity be attributed to the fact that for ages the plant has always been exclusively multiplied by means of bulblets? To break up this stability it was necessary to introduce hybridisation. To this end I collected in the living state the greater part of the known species of Crocus, about fifty, without counting the varieties—the Saffron is a Crocus: *Crocus sativus*. Among these species there are some which have a certain analogy with our Saffron, principally as regards the stigma—for instance, *C. odorus longiflorus*, *Thomasii*, *Pallasianus*, *Elwesii*, *Corsicus*, *medius*, &c.

All attempts at fertilisation by means of the pollen of these various species failed to yield any results. Finally, in 1862, I received from M. Heldreich, professor at Athens, an original plant from the island of Syra, of *Crocus græcus* (*Cartwrightianus*, Herb.?) which supplied my need. The pollen of this *græcus* easily fertilised our *sativus* (saffron), and I obtained almost as much seed as I wished for, the sowings of which, aided by selection and a little chance, have given me very numerous varieties. Some of these have been described, and even figured, for instance, in a note by M. Duchartre, *Journal of the Société d'Horticulture of France*, 1879, p. 171; and in the remarkable work of Mr. G. Maw, *A Monograph of the Genus Crocus*, pp. 58 and 74.

The most recently obtained of these varieties merits special mention. This is what I wrote on the subject in the *Bulletin de la Société d'Acclimatation*: "The bulb of this hybrid, to judge by its small size, would not have strength to flower, at the utmost I might have expected a solitary flower or three stigmas, but instead of three it carries nearly thirty. Furthermore, this mania (*affolement*) for stigmatisation seems to pervade all its organs. In the first place, the pseudo-leaves, forming the sheath which envelops the leaves properly so called, have a saffron tint; then several of the leaves, and even the floral bracts, and sometimes the anthers, are surmounted by a portion of stigma clearly characterised, the stem of which is furnished with stigmatic papillæ. The botanists who examined this hybrid at the Chrysanthemum Exhibition of the Société d'Horticulture in 1896, found it very interesting. None of them knows of a case of transformation of bracts and leaves into stigmas. But the teratological phenomenon has less interest for me than the practical and agricultural side. Horticulturists strive to change stamens and pistils into petals and sepals, in order to obtain double or full flowers. I work in an entirely opposite direction. I try to transform the floral organs into stigmas, and I have even gone beyond this, since this stigmatic proliferation invades even the sheaths, the bracts, and the leaves.

"Thirty stigmas instead of three! Nay, even leaves changed into stigmas. Here is something for Saffron cultivators to dream about. Some of them may go the length of imagining that he may reap the stigma-bearing leaves of his Saffron bed, as he would his cornfield, but we are not quite at that point yet. In fact, I must warn the Saffron-growers that these stigmas are not yet perfect. At first they are a little thin—it is true that their number, thirty instead of three, compensates, and far more, for their lesser thickness. But they have one serious defect,

instead of rising 10 to 15 cent. above the soil, as is the case with cultivated Saffron, they present themselves at the level of the soil, and their gathering is consequently very difficult. However curious and precious therefore my hybrid may be from the agricultural point of view, it has still the need to be worked up and improved by means of sowing and selection."

Unfortunately that is a long-winded work. Indeed, the sowing that I made of the precious seed gathered in the year 1897 from this hybrid will scarcely flower under five to six years. Will one sowing attain perfection, or may it not probably be necessary to await still another generation, that is to say, a further period of five or six years?

I should not forget to say that I possess still some hundreds of young seedlings from one to six years old, which will not give me their first flower for one, two, three, four, five, and six years. Who knows but that among these dear unknowns there may be the phenomenon I have been waiting for, for more than fifty years. In short, I possess at present very interesting varieties, which may be called plants full of hope.

So far, these hybrids have had but a botanical and theoretical value, but there only remains, it is reasonable to expect, a slight effort to be made in order to arrive at an improved type, which may render veritable service to Saffron cultivators.

[NOTE.—The preceding paper was accompanied by two others: Monsieur P. Duchartre's "Note on a Crocus with Monstrous Flowers" and "Note on a Monstrous Saffron," by Monsieur L. Lutz.

Both relate to the hybrid *Crocus sativus* raised by Monsieur Chappellier; but as they only describe in detail the peculiarities of structure of the monstrous flowers, without special reference to their hybrid origin, we do not reproduce them, although from the morphological standpoint they are extremely interesting.]

ATTEMPTED HYBRIDISATION OF DIOSCOREA.

WITH A VIEW TO OBTAINING A VARIETY OF CHINESE YAM (DIOSCOREA BATATAS) WITH A SHORT TUBER PERMITTING OF EASY EXTRACTION FROM THE SOIL.

By Monsieur P. CHAPPELLIER.

I HAVE chiefly fertilised the female Yam of Decaisne (*D. Decaisneana*) which has a spherical tuber with a production almost nil, with the pollen of the Chinese Yam (*D. batatas*) having a very long tuber.

I have even attempted—*in extremis*!—to cross *D. pyrenaica*, a pigmy, with *D. batatas*, a giant, but, as was to be feared, this hazardous attempt yielded me no result.

My experiments, pursued for ten years, have given me a great number, several thousands, of young plants with tubers of varied forms, sometimes irregular and inconstant. Nevertheless, several of my hybrids among the more recent ones appear to advance towards the desired end. Some plants carry from four to eight tubers not exceeding 45 centimetres in length, whilst the tuber of the Chinese Yam is normally single, and attains a length of 80 centimetres to 1 metre.

One of the individuals obtained in the course of my experiments produced at one and the same time male and female flowers.

The seeds have not germinated, and this variation has not been maintained.

NOTE ON A HYBRID OF MIRABILIS.

By Monsieur P. Chappellier.

Mirabilis longiflora fertilised by the pollen of *M. jalapa* has given me an interesting hybrid.

This hybrid is, like many others, notably more vigorous than either of its parents—in fact, it has tubers of good size, about three years old, furnished with supports and forming bush-like plants, 2 metres in height, and if the branches, unsupported, are allowed to take their natural direction, a single plant can form a clump nearly 4 metres across.

On a strong plant I have counted nearly 400 flowers, exhaling a sweet odour, and which, be it understood, are renewed every day.

When frost sets in, the plants are still covered with buds.

Monsieur Naudin formerly cultivated my hybrid at the Museum.

I mention it as possessing in the highest degree the character which is termed "disorderly variation" (*variation désordonnée*).

The seeds of my hybrids are fertile, but they never exactly reproduce the type. There is found among the sowings the most varied and the most bizarre forms; some of them are so weakly and feeble as to appear to have been born vitally incapable.

The true plant can therefore only be propagated by buds or divisions of the tubers.

Monsieur Lepelletier had previously obtained a hybrid Mirabilis, all trace of which has disappeared. Desiring that mine should not suffer the same fate (as it is not in commerce), I offer to give young plants to such amateurs as may desire to have them.

A FEW NOTES ON REPRODUCTION IN HARDY PLANTS BY MEANS OF HYBRIDISING SPECIES AND CROSSING VARIETIES.

By CHARLES STUART, M.D., Fellow Bot. Soc. Edin., Member and formerly President of the Berwickshire Naturalists' Club, and Member of the Scottish Alpine Botanical Club.

WHEN I had the honour of receiving the kind invitation of the President of the Council of the Royal Horticultural Society to attend the Conference of Hybridists at Chiswick, and contribute a short communication, I felt somewhat diffident as to the nature of the information I would be expected to give. Upon consideration I came to the conclusion that, as the scientific element would be better elucidated by the many distinguished botanists whose names appear on the list than I ever could hope to do, it would be more interesting to give a short statement of an amateur's attempt to raise new varieties of hardy plants than to enter into a detail of the process of hybridity. Like many others, I have had in my attempts many disappointments, perplexities, and failures in the results of these operations, but upon the whole there has been much pleasure, and some profits. As a rule very careful selection is required, as even with all the skill of the hybridist many of his seedlings are deficient in some vital point of constitution, however sound the parent may be in that respect. A small minority is all that need be expected to be better than the parent in crossing varieties, and besides an accurate knowledge of quality is necessary to ensure "the survival of the fittest." No more delightful satisfaction can be experienced by the amateur florist than to watch the development of the beauties of his seedlings from which he expects an advancement in quality. It is not in every season that the elements are propitious for hybridising operations; and even when successful crosses have been effected, do the results always satisfy the anticipations of the operator? The month of June, 1899, has been an ideal one to the seedling raiser. There has been more continuous sunshine than for many years. The temperature at the same time has been very high, and the weather on the whole has been very suitable for crossing hardy plants as well as exotics. The early spring was the worst on record, and in consequence the Primulaceæ, from which so much was expected, are a miserable failure as regards seed. With this preface I shall now endeavour to give a short statement of work carried out during many years of my life.

MIMULUS TIGRIOIDES.—More than forty years ago the late Mr. Robert Stark, a well-known Edinburgh botanist and florist, brought me a plant of *Mimulus cupreus*, a native of Mexico, saying, "There is the very thing for you. Cross the garden Mimulus with the pollen from this plant, and you will get something different from the ordinary forms." At the time I had no plant of Mimulus in the garden, but I speedily got 'Scarborough Defiance,' a good Mimulus in its day, and potted it and

M. cupreus, growing them together in a cool greenhouse. In the month of May, when they were both in bloom, I removed the stamina in an imperfect condition from several flowers of 'Scarborough Defiance,' cutting off the remaining flowers on the plant, after examining the stigmas with the glass to see that there was no pollen already there. Waiting till I saw that the stigmas had matured, I took the pollen from M. cupreus, and dusted over the two-lipped stigmas of 'Scarborough Defiance.' They showed an irritability well worthy of observation. On depositing the pollen, the two lamellæ or plates of the stigma clapped together, effectually protecting the pollen and preventing the intrusion of insects. Tying a piece of scarlet worsted round the stems and footstalks of the fertilised flowers, I waited patiently for the maturation of the seed pods, which contained a large quantity of minute seeds. The seed, as you all know, is of a dust-like character, and requires careful manipulation to get it to germinate and produce plants. Having prepared some seed pans, filled with vegetable mould and sprinkling of sand, finely sifted, watered the soil, and allowed it to drain, I sowed the seed, pressing it into the soil with a piece of glass. Placing the seed pans on a moistened surface in a shady situation, a good stock of seedlings appeared, and got past the stage of childhood.

In the following spring, upon their flowering, I found the whole to be identical in character. The plants were very dwarf in habit like the pollen bearer, short jointed, and the stems of a reddish-brown colour. The flowers were much smaller than the seed bearer, yellowish in colour, and covered with minute dots; clearly demonstrating the powerful influence of the pollen of another species, and keeping more to the character of the pollen bearer, and proving the dwarfest of the Tigrioides section of the Mimulus family. This hybrid was sent out by Mr. Cannell, of Swanley, and was a favourite in its day for bedding and for edgings to flower beds.

Coloured Zonal Geraniums.—In 1864 or earlier the floral world was curious to know how a tricolour-leaved Geranium, named 'Mrs. Pollock,' had been obtained. Mr. Grieve, a native of Berwickshire, but at the time I mention residing near Bury St. Edmunds, had the honour of originating this particular strain. His work I have verified in every particular. He found by crossing Geranium Golden Chain with Golden Pheasant that he obtained a strain which has produced the most wonderful results in coloured leaves that can be imagined. He found his plants very weak in constitution, and some would not live at all, and he was at his wits' end. To give vigour of constitution he chose a dwarf green horse-shoe Geranium as the seed bearer, taking the pollen from the high-coloured varieties. The higher in colour his seedlings were the more tender in constitution they proved. Taking a strong-constitutioned horse-shoe-leaved Geranium as the seed bearer, with an extra dark zone for my seed bearer, a fine sunny summer, not so common now as then, afforded me facilities for fertilisation of the flowers. As the flowers of the Geranium above mentioned opened the stamina were carefully removed before the maturation of their pollen. At the warmest period of the day, when the stigmas were in condition, the pollen from some of Mr. Grieve's high-coloured seedlings was dusted over the three cleft stigmas

of the horse-shoe, having in the first place observed with the glass that no pollen grains had been deposited there by insects. Carefully enveloping the flowers operated on in net bags tied with scarlet worsted, the flowers fertilised speedily withered. Eventually I succeeded in harvesting a certain amount of seed. The silky, feathery awn, where it is attached to the axil, soon shows when the seed is ripe, and requires to be sharply looked to, for if not carefully protected would soon fly away.

On ripening, the seeds were gathered and sown at once in pans, placing them in gentle heat. The seedlings appeared in three weeks; a certain number showed a stripe of white, or rather cream colour, on their seed leaves. All having green seed leaves were thrown out. The produce was grown on in pans and seed boxes for some time, a large proportion showing a provoking amount of green; a smaller proportion parti-coloured leaves; a still smaller proportion white or yellow; completely etiolated individuals speedily died a natural death. After careful nursing through the winter there were a considerable number to prove in the spring: those having parti-coloured leaves I found most inclined to send out a branch with the true characteristic tricolour marking. The branch was cut off and struck; the plant so raised kept its character most wonderfully. Of the collection of seedlings some did not break or develop their true character for years, although it was easy to see the golden blood in their veins. In our moist climate of Scotland I found them very delicate, and inclined to damp off in the winter season. In dry summer weather no more beautiful objects could be looked at than a cold frame filled with tricolour and silver-leaved Geraniums, although like many other good plants they seem to have gone out of fashion, probably assisted by damp seasons, when they were difficult to keep.

TUFTED PANSIES OR VIOLAS.—The Garden Pansy has been a favourite with all lovers of flowers, and its florist varieties have been brought to a high state of perfection and beauty. Its origin is still uncertain, our native *Viola tricolor*, crossed with *Viola altaica*, having the honour of furnishing the original plants from which all the florist varieties have been derived. As far back as 1835 the march of improvement in quality of petal, size, and shape commenced; and the illustrations of the Pansy in the floricultural magazines of that period give some idea of the immense improvement that has been brought about by crossing varieties of the Garden Pansy. With its advancement in refinement, however, it was found that its constitution did not improve, and costly varieties had a habit of suddenly dying in hot weather. This led hybridists to turn their attention to endeavour to secure a hardier race by crossing some of our wild species with the Garden Pansy, the result being the plant now popularly known as Viola, but a still better name is Tufted Pansy. At present it is a plant with a very dwarf habit, abundance of fibry roots, moderately large flowers, and a compact tufty appearance. The fibry roots enable the plant to withstand the changes of temperature and climate which affect plant life, and which we are all so well acquainted with. In general, one man succeeds in crossing two plants of different species, while another takes up the idea and carries out this fertilising process a step farther. In 1873 Mr. B. Williams, of London, succeeded

in getting true hybrids between *Viola cornuta* of the Pyrenees and the Garden Pansy. Following up his idea, I fertilised *Viola cornuta* with pollen from Blue King Pansy (a bedding Pansy), and ripened a pod containing twelve seeds, which were at once sowed. Every seed germinated, and in the following spring the plants flowered with flowers of identical character, the long spur or horn seen in the under petal of *V. cornuta* being very conspicuous. These flowers were quite distinct from anything in the Viola family I have ever seen. Indeed it is safe to write that the cross had never been made till the plants of Mr. Williams and those above mentioned appeared. I tried to reciprocate the cross by taking pollen from *V. cornuta* and applying it to the pistil of the same family ('Blue King'). The produce was a failure, and many failures besides that recorded have occurred to other persons who have endeavoured to raise Tufted Pansies in that manner, the result being straggling habits in the plants and large Pansy-looking flowers. The next step followed with the seedlings from *V. cornuta* crossed with Pansy 'Blue King' when in full bloom was to fertilise the blooms with various coloured Pansies, the results being flowers showing almost every colour except yellow. The plants were of true tufted character, with blooms showing the horn or keel of *V. cornuta* species. Afraid lest these crosses should become too similar to the Pansy, I took pollen from the original *cornuta* hybrids and fertilised some blooms of those above described. "The stocks being sound this in-and-in breeding does not necessarily impair the vigour of the race." Nor did I find it so in this instance. If any flaw in their constitution existed, there is no doubt that, sooner or later, a similar defect would ultimately appear in the progeny; but this did not happen here, as the produce of the cross proved healthy in every respect. These seedlings had flowers three times larger than *V. cornuta*, and were of various colours, very tufty in habit, some almost proliferous, also most abundant in blooming. Mr. Barron, Garden Superintendent at Chiswick at that time, induced a number of growers of Violæ to send selections from their stock to Chiswick Gardens in order to test by comparison when growing together which were the best varieties. His wish was responded to by a large number of growers, and a very interesting exhibition was the result. Mr. Barron wrote to me at the time inquiring how I had got the cross, at the same time stating that these plants had flowered more continuously than any of the varieties being tested there. Upon affording the information required, the Floral Committee of the Royal Horticultural Society awarded me six First-class Certificates for varieties 'Lady Susan Suttie,' 'Mr. Williams,' 'Hillside Beauty,' 'Ormiston Georgia,' and 'Dr. Stuart.' These certificates were awarded in 1874-5. The varieties were now grown on, by myself and friends, for several years, and were found to be excellent bedders and very hardy in withstanding climatic changes. As a bedding plant the Viola is peculiarly adapted to our Scottish climate, delighting as it does in cool, moist soil. The flowers are capable of making a continuous display in the flower-beds to compete with it, and by hand-crossing the varieties are numberless. I may mention here that these varieties were all more or less rayed in the centre of the flower. A floral friend remarked, "With regard to a white-rayed self, if you could only get

that flower, without any rays in the centre, it would, in my opinion, be an improvement." Keeping a sharp look-out on the seedling beds, I did not succeed in obtaining what I was searching for till the year 1887, when, for the first time, I observed a white flower, entirely rayless, dwarf in habit, and with most pronounced almondy perfume. The plant was removed and propagated, and grown on next season, some blooms being sent to Mr. Robinson, editor of *The Garden* newspaper, who at once sent a favourable report. In the following year, 1891, 'Violetta' was figured in that publication, and with many florists it still holds a first place as a bedder. With pollen from 'Violetta' a white-rayed self, still in cultivation, was crossed, which yielded 'Sylvia,' a variety more grown than any Viola yet raised. Of first-rate hardiness, its freedom of flowering is remarkable. By taking 'Violetta' as a seed-bearer, and using pollen from rayless flowers, a great many varieties have been raised, chief among them 'Blue Gown,' 'Florizel,' 'Rosea pallida,' 'Christiana,' 'Coolgardie,' &c. By careful selection the rayless strain of Tufted Pansy has been fixed; and now, if more colours could be got into the flowers, this strain would soon be preferred to the ordinary rayed form. With the fine colours in the Peacock Pansy I was induced to try a cross with the rayless strain. A hundred and fifty plants, the result of the cross, were tested; but the flowers turned out of the most varied character, with one exception, which proved a first-rate departure. A fine reticulated blue; perfectly rayless; and with a good dwarf habit. It was named 'Border Witch,' and is well known as a show flower, and has been certificated. Two years ago Mr. Rowberry, of London, a distinguished amateur, kindly sent me plants and blooms of a yellow self Viola named after himself. The flower was of fine quality, quite rayless, but seemed to have more of the Pansy than Viola in its constitution. This variety, from its fine colour and sturdy constitution, has been the origin of many new forms; but those from 'Mr. Rowberry' have not habits of the dwarfest kind. The pollen from 'Mr. Rowberry' crossed with some of the dwarfest rayless sorts has originated a set of new bedders, which I am convinced in a short time will drive all existing yellow bedders out of the field. 'Coolgardie' × 'Rowberry' has yielded a set of bedders this season varying in shade from orange to paler yellow, which are an immense advance on existing varieties, both in earliness and freedom of flowering. The latter quality comes from 'Mr. Rowberry,' for most of our rayless yellows are by no means early flowerers. Then as to colour, this London variety has furnished several almost orange shades of colour, which are a most desirable attraction. Many seedlings have to be grown before obtaining an orange-coloured Viola, but at present there are several new flowers of this year which answer the description. Among others Messrs. House, of Bristol, have sent out 'Crème d'Orange,' which, during the warm weather in June, has been singularly fine in colour, and could be picked out among hundreds of ordinary yellow varieties. The present taste of the public is for large flowers. 'Mr. Rowberry' will furnish plenty of plants with this desideratum, being a very free seeder. This is not desirable in all cases; as bedding varieties look much better with moderate-sized flowers and plenty of them. The fashion of showing Tufted Pansies in sprays done

up with wire is open to criticism; but it seems "the fashion," and we must submit in the meantime. There is just the question whether or no the Tufted Pansy should ever be shown in sprays at all. As a cut flower the blooms arranged in stalked glasses, garnished with their own foliage, have a good appearance on the table. The Tufted Pansy, however, looks best treated as a perennial in an open situation out of doors with masses of bloom on dwarf plants, where both habit of plant and quality of bloom can be examined. The dwarfer the plants are, with free-flowering properties, the more desirable they are. Take 'Blue Gown' as a type. If every variety had its habit and free-flowering properties we would soon possess a race of Tufted Pansies which would supersede all others. In time this desirable end will be attained.

AQUILEGIA STUARTI.—In May 1880, having plants of *Aquilegia glandulosa* (Grigor, of Forres, N.B.), as sent out in 1848, also *Aquilegia Witmannii*, in pots and in flower, at the same time, I fertilised a flower of that species with pollen from *A. glandulosa.* A ripe pod of seed was gathered in less than a month and sown at once. Seven plants lived, to be planted out on a sheltered border in the autumn. I had almost forgotten their existence, till in the end of May in the following year a floral friend, who was staying here, on looking round before breakfast came on the first open bloom on one of the plants. He asked me where the plant had come from, as the flower was the finest he had seen of the Columbine family. Before referring to my notebook I could hardly tell him, but that they were crossed seedlings I knew quite well. The seven plants all bore flowers identically the same, the top blooms measuring more than four inches across. The following season I took up a quantity of the blooms to a meeting of the Berwickshire Naturalists' Club, and showed them to the late Professor Balfour, of Edinburgh University, and the late Mr. John Sadler, then Curator of the Botanic Gardens, Edinburgh, and many other competent judges, who all considered *Aquilegia Stuarti* a first-rate novelty, and it was there and then named by Professor Balfour. The original *A. glandulosa* I have grown on and off for forty years. It is a notoriously shy flowerer, and we used, many years ago, to consider it a triumph to get it to display its beauty at all. All I claim for *A. Stuarti* is that it is an improved form of *A. glandulosa*, refined in colour, free flowering, very large and attractive in appearance. It is perfectly hardy, and flowers three weeks before other Columbines, always coming true from seed. It does not, however, succeed in every place, and I know persons who tell me they cannot flower it. After several years' experience in growing and rearing the plant, I recommend that a bed be trenched 2 ft. deep, and well enriched below; the bed raked smooth, and the seed newly ripened, sown thinly in rows, the plants being allowed to remain where they are to flower. The plants, if necessary, may be thinned to a foot between, and the same distance between the rows. In process of time the fine foliage will come to cover the entire bed, and there will be abundance of blooms on moderate sound stems. With a little rotted manure as a top dressing in the autumn, the plants improve in vigour every season, and a three-year-old bed with thousands of blue and white flowers is a sight to see. The specimens sent to the editor of *The Garden* were taken at random from a bed of the

character described, and the beautiful illustration in the number of *The Garden*, October 13, 1888, was drawn from these specimens.

Hybrid Trollii.—Everyone is acquainted with our native *Trollius europæus*, or Globe Flower, with its beautifully imbricated coloured calyx, which it unfolds to the sun and closes at night, the Luckan Gowan of Scotland, and one of our most beautiful native plants. From its symmetrical shape and general hardiness, I thought a cross with the higher coloured American form might yield some improved varieties. A few years ago, with that view, the stamina in an immature state were clipped from some blooms of *Trollius europæus* and the flowers marked, and having placed some blooms of *T. americanus* (?) in a sunny window, I succeeded in getting plenty of pollen, which was applied to the pistils of our native plant. From the complete natural covering of the flower, insects, as a rule, find some difficulty in both entering and getting out of the blooms. Hence when the pollen of *T. americanus* is dusted over the stigmas, there is less chance of interference. The seeds matured and were sown at once, small, black, shining objects, which if not sown at once refuse to germinate. A goodly array of small plants appeared, and were pricked out into boxes and pans, and ultimately planted in the open ground. They took two seasons to flower; indeed it was the third season before they became good flowering plants. A large proportion of the seedlings showed the effect of the cross, displaying the orange florets of the *T. americanus*, with improved size of flower and colour in the calyx, all mostly of a vigorous habit of growth. The corollas of the British form never show anything but a pale yellow shade; but when that plant is crossed, most of the seedlings, but not all, demonstrate the influence of the pollen of the other species. The best seedling of the whole, lost from over-kindness, was of a brilliant orange colour, twice the size of *T. Fortuni*, beautifully imbricated, but seemed delicate in habit. Mrs. Kingsbury, of London, painted it and others; Mr. Dean saw the blooms, and compared them to Orange Roses. During June, 1899, they have bloomed to perfection, in many shades of orange and deep yellow. There remains some doubt as to the pollen bearer being *Trollius americanus* at all, as a botanist from New York writes me that the American form was a shabby plant and half single. In this instance, however, the pollen bearer happens to be a very handsome form indeed, with bright orange florets, and of robust habit. The Trollius family is among herbaceous plants one of the finest in its season of flowering, and well worth the attention of the hybridist in trying to produce both size of bloom and colour also.

Primulas.—The Primulaceæ exhibit an anomaly in their reproductive organs which puzzled many hybridists till the late Mr. Charles Darwin elucidated the cause. He found some Primulæ with short stamina and long pistils, and others with long stamina and short pistils. He also, by experiment, proved, in order to get fertile seeds, it was necessary to have pollen from plants with the same length of stamina and pistils. Besides, the size and colour of the pollen grains varied, and was another cause of infertility. The infertility which occurs in various dimorphic and trimorphic plants when illegitimately fertilised, that is, by pollen taken from stamens not corresponding in height with the pistil, differs much in degree, up to abso-

lute and utter sterility, just as in the same manner occurs in crossing distinct species. Florists who have worked to improve the Polyanthus, I mean the Gold-laced show variety, must all have observed the great difficulty of obtaining good fertile seed. When the stamina occupy the centre of the flower or corolla, florists denominate the condition as thrum-eyed, and is the true form, other things being equal. When the pistil protrudes in the centre, then "pin-eyed" is the name applied. It is no use to apply pollen from a short-stamened flower to the protruding pistil of the pin-eyed flower, but with pollen from a long-stamened flower a cross can be obtained that will produce good flowers from fertilised seed. This is exactly how florists work in obtaining new varieties. A pin-eyed flower of fine lacing and trussing habit is chosen for the seed bearer. The pistil is dusted with pollen from a good show flower, which must be thrum-eyed and with long stamina; and, other things being favourable, good reliable seed is the result. No flower has given worse produce than the show Polyanthus, simply from the fact of the ignorance of the raisers, till Mr. Charles Darwin proved by his own experiments the reason why, and solved the problem. In following out his theories and practice, I have during the last few years tried to get the bright colour of some of our Alpine Auriculas infused into the Primula Auricula of the Alps and mountains of the Tyrol; and I do not despair of getting the hardy free-growing *Primula marginata*, with its beautiful foliage, to reciprocate a cross with the pollen from some of their high-coloured relations. As it is, *P. viscosa*, *P. integrifolia*, and *P. ciliata* have already furnished me with encouraging results, which in another season I hope to improve upon. The weather during the spring has been so cold, sunless, and wet that little could be done in the way of crossing the varieties of Primula. Although the plants are kept in the meantime in rudely constructed cold frames, very little seed will be got. Careful testing of seedlings already obtained is just as important, and I hope next season to have something to show. There is a vigour of constitution in these crossed seedlings which contrasts favourably with that of the old show varieties of Auricula, which owing to lack of constitution are now only grown by some enthusiasts, beautiful though they undoubtedly are.

FERN CROSSING AND HYBRIDISING.

By CHAS. T. DRUERY, F.L.S., V.M.H.

THE absolutely microscopic nature of the organs which, in Ferns, perform the part of flowers renders their systematic crossing or hybridising an extremely difficult matter, and, humanly speaking, it is impossible to proceed with two Ferns, with the same certainty of knowledge that the preliminary steps are sure and indubitable, as the florist can with two distinct flowers. In the one case he deals with something he can see and handle: he can take his scissors and remove the stamens before the pollen is ripe, and in other ways secure a virgin flower on the one hand, while to remove the pollen from another set of stamens on another plant is the simplest matter imaginable. With both individuals he starts on a clear and definite basis, and with ordinary precautions against intrusive insects, &c. can practically swear when the seed-pod swells that it contains A plus B. With the Fern, however, it is quite another matter. Even though we gather a fertile frond of a known variety, and isolate it by placing it between clean paper in the dwelling-house, the chance of stray spores from other Ferns having been shed upon that frond beforehand is always existent. Uncertainty No. 1. Assuming, however, that a pure culture is obtained, the prothalli grow profusely and healthily, but when their time for fruition is near we can only discern, and that moreover upon their undersides, even with a good lens, a number of tiny pimples, some spherical and some oblong. A pin's head would accommodate a dozen of either sort. Within the round ones are packed a score or two of little tadpole-shaped organisms, only visible under a high-powered microscope; and at the bottom of the oblong ones is an embryo seed a few degrees bigger. These are the elements the Fern crosser has to deal with, and to carry out his ideal he should carefully lift one of these tadpole bodies just when it bursts its round-headed container and starts on its wedding journey across the ocean of a dewdrop, and then carefully convey it to another and distant bride selected for it, in lieu of the maiden close at hand. Meanwhile it is fairly certain that that other bride has many other suitors, and the new one may consequently arrive the day after the wedding, when, of course, the match-maker is frustrated. He is frustrated, but how is he to know it? To come back to botanical phraseology, he may even have isolated the archegonium of one prothallus by severance, but as there is no doubt whatever that cross-fertilisation occurs through the myriad tiny insects that are invariably present, even then there is a risk, and in fact the risks, difficulties, and uncertainties are practically so unavoidable that a different method altogether is compulsorily adopted. The usual course when a cross between two distinct Ferns is desired is simply to collect the spores of each as carefully as possible with a view to eliminate strays, and then either to mix them intimately before sowing, which is the better plan, or sow them one after another rather thickly in the same pan. By this means a proportion of the distinct spores are bound to

germinate in such close juxtaposition as to cause more or less overlapping when the prothalli develop, and obviously we thus produce conditions favourable to cross-fertilisation, especially if at the proper time, that is, just before the prothalli are full size, we produce a small inundation,

A A+B B

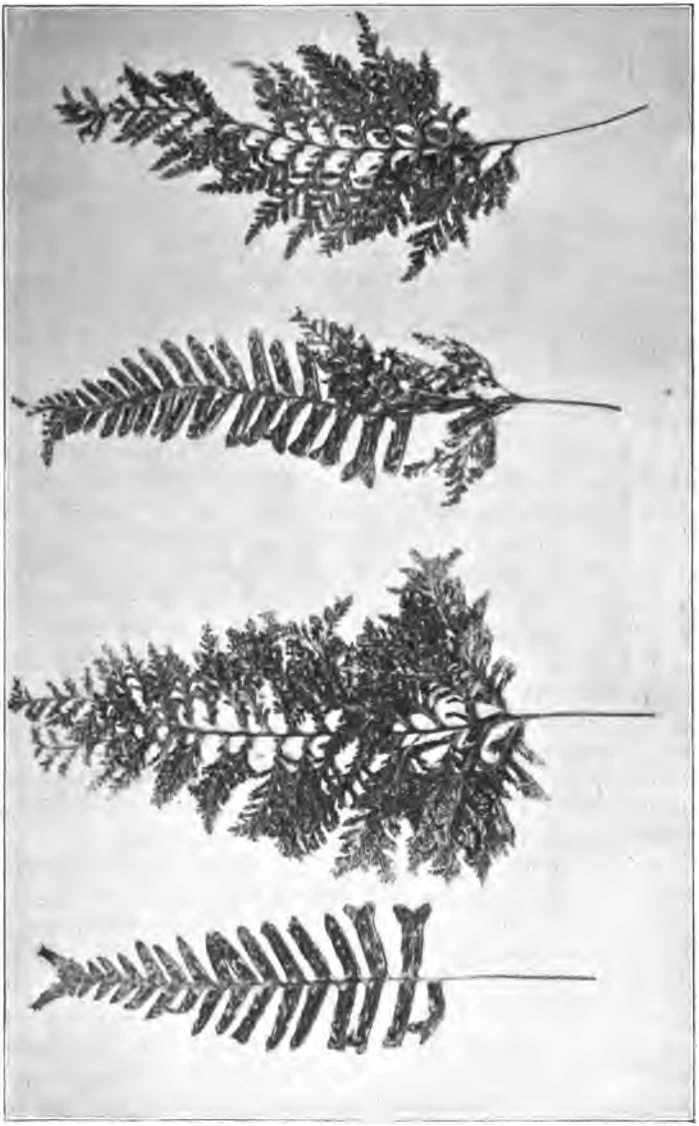
FIG. 107.—LASTREA DILATATA LEPIDOTA (A) × L. D. CRISTATA (B)
L. D. LEPIDOTA-CRISTATA (A+B) STANSFIELD.

either by immersing the pan until the water percolates through the soil, and just submerges the undersides of the prothalli, or by watering overhead, which is less to be commended. My own idea of the best way is that the pan should be placed in warm water, say about

70 degrees or so, and when the prothalli are reached by the rising water to let them stand thus for half an hour or more, so that, stimulated by the warmth and wet, a large number of the ripe antheridia may burst, when their contents would naturally, in the prevailing flood, find their way in all directions, and certainly afford the maximum of chances for foreign alliances. Shorter immersion would reduce these, and a mere dip and out again would carry the bulk of the free antherozoids into the soil before they had a chance to wander. The above suggestions as to sowing together for a cross apply necessarily to such varieties or such species as arrive at the fruition stage in their prothalli about the same time. Ferns, however, vary greatly in this respect; some bear spores which germinate at once and arrive at maturity at a time when others have only begun to form prothalli. Obviously with such ferns a cross can only be arrived at either by sowing the slow one thinly much earlier than the other, and subsequently sowing in the same pan, the rapid grower broadcast among the other existing prothalli, or by pricking out patches from separate sowings which have arrived at maturity and placing these closely together in a pan by themselves in the hope that subsequent flooding or other means of transfer may lead to the desired results. The former course is clearly preferable if the cultivator is sufficiently acquainted with the relative sluggishness or activity to be able to calculate when to sow the second crop. Finally there has been put forward as a theoretical possibility the following plan. The archegonia, or seed-vessels, are as a rule situated just within the indentation of the heart-shaped prothallus, and the antheridia or equivalents of pollen masses among the root-hairs covering the larger and other half of the prothallus. The prothallus is most retentive of life, and will bear with impunity almost any amount of cutting up. We will therefore suppose two pans of thinly sown spores, eachone of a different variety or species ; as soon as the prothalli are half grown, *i.e.* before any fertilisation is likely, we take a keen razor and cut each prothallus across just below the indentation. We do this in both pans, carefully removing the male halves in each and neatly embedding them in the soil, just touching the archegonial portions of the other variety or species which have been left *in situ*, and which if deprived of root-hairs by the operation will certainly develop more if gently pressed into the soil and kept close. In this way the chances of self-fertilisation would be reduced to a minimum, and those of a cross increased to a maximum, as the subsequent growth of both halves would bring them into extremely close juxtaposition. There is, however, a good deal of irregularity in the arrangements of the organs on the prothallus, and hence this sort of division cannot be depended upon absolutely as separating the sexes.

Having said so much (or so little) of the *modus operandi*, we may now glance at the results already obtained, namely, by simply sowing together and trusting to chance for the results. To Mr. E. J. Lowe must certainly be accorded the merits of the first most striking hybrid, viz. that effected by him between a cruciate form of *Polystichum angulare* and a dense form of *P. aculeatum*, the result being a cruciate *aculeatum*; and I may here remark that it is only where absolutely distinct

forms such as these are crossed that we can be sure that the progeny is a cross at all, because once a fern or other plant has broken away from the normal plan of growth, its progeny is apt to vary again, probably more or less on the same lines, but not necessarily so. Fortunately, however, numerous crosses have been effected under circumstances of



A A + B C B

FIG. 108.—POLYPODIUM VULGARE BIFIDO-CRISTATUM (A) × P. V. ELEGANTISSIMUM (B). P. V. ELEGANTISSIMO-CRISTATUM (A + B). C shows a frond of the cross A + B reverting to one of the parents A, and not to the normal form.

choice which eliminate this doubt. Mr. Clapham, for instance, sowed the finely cut form of *Polypodium vulgare*, known as *elegantissimum*, with another form known as *P. v. bifido-cristatum*, an attenuate crested form. *Elegantissimum* has a peculiar knack of partial reversion to the normal. The offspring of the cross was not merely a more or less tasselled

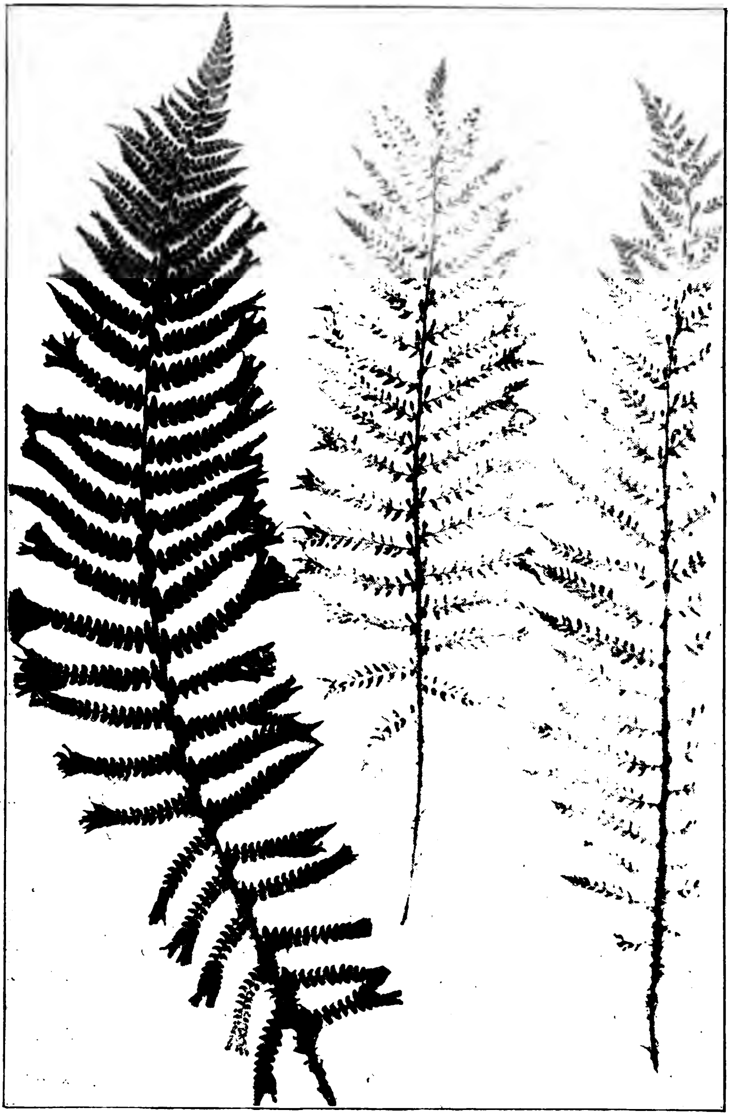
form of *elegantissimum*, which might have been a secondary sport *per se*, but when it tried to get back to normality it produced a frond of the true type of *bifido cristatum*. Fig. 108 shows fronds of both parents and of the result of their union.

Mr. Schneider, in his marvellous hybrid (the most striking yet produced, to my mind) between this same *elegantissimum* and the huge exotic *Phlebodium aureum*, finds the hybridism confirmed by precisely the same character of partial reversion. In another cross between *Athyrium filix fœmina Victoriæ*, the most remarkable Fern yet found, bearing percruciate and tasselled fronds, and *A. f. f. setigerum* with translucent, bristly excrescences all over it, the result is *A. f. f. Victoriæ*, true to type, but bristling throughout with the *setigerum* character. Crosses and hybrids of this class bear their certificates of origin upon their fronts: in each case the parents are pure-bred original finds, and in their offspring the strong parental marks are distinctly brought out. At Kew there are a great number of marked instances among the Polystichums raised by Colonel Jones and others by crossing his polydactylous find of *P. angulare* with many other varieties. In this Fern there must have been some special prepotency, for the crosses were innumerable, but in every one that I have seen as yet they are ear-marked by the parental defect of producing here and there non-polydactylous divisions and irregular furcation to boot. One and all present this feature, which establishes the dual origin convincingly, but spoils the plants. Fig. 109 shows fronds of one of these crosses as typical of all, the × marks indicating the defects.

Among hybrids between species, I must not omit to mention Mr. Lowe's indubitable cross between *Scolopendrium vulgare* and *Ceterach officinarum*. As will be seen from the fronds of it exhibited, they are of Ceterach pinnation, though confluent at the tip and quite scaleless, while the fructification can be detected on the basal pinnæ as in faced pairs, *i.e.* Scolopendrium fashion, and further up, as single lines, *i.e.* in the character of the Spleenworts. I do not know whether this plant is still alive, but the fronds shown establish its hybrid character and determine both parents with certainty. I invite particular attention to this exhibit, as I fear it constitutes all the evidence existing, and I should like it to be confirmed by others. In "European Ferns," p. 137, a presumed natural hybrid between the same two species is figured, but considering the great varietal capacity of *Scol. vulgare*, and the existence of numerous pinnatifid forms, the hybridism in that case is, to my mind, extremely doubtful.

Having thus cited a few of the conclusive evidences of the possibility of crossing, not merely varieties but also widely different species, and given a few hints as to the *modus operandi*, the next thing is to give some idea of the directions in which this possibility may be utilised to the best advantage. *Polypodium Schneiderii* is, I think, eloquent with two possibilities of extreme value. The one is that of enhancing the simple beauty of many exotics by alliances with the highly ornate forms which our British hardy species have assumed, both under purely natural conditions as wild finds and under selective culture of the progeny which they have yielded. The other is the increased capacity of exotics,

so hybridised, to withstand low temperature, due to the infusion of hardy blood. In Ferns, thanks to the curious fact that the prothallus, or green scale upon which the flower homologues are produced, is almost constant in size throughout all species except the Filmies, the minutest species



B A + B A

FIG. 109.—POLYSTICHUM ANGULARE POLYDACTYLA (B) × P. A. LINEARE (A). RESULT OF THE CROSS (A + B).
The × marks indicate defects in parent and progeny.

and the largest Tree Fern commence their career under practically identical conditions, and crossing and hybridisation therefore are not limited as in flowers by incompatibilities between length of stigma and size of pollen. Hence, so far as size is concerned, there is no bar, and the

smallest may be allied with the largest if specific or generic differences be not too great. Consequently, though our British Spleenworts are all of comparatively small growth, their varietal forms may presumably be imparted to many of the grand large-growing exotics, and the task is the better worth attempting, as the genus is peculiarly exempt from the tendency to form tasselled or crested varieties, though examples of such occur among our native species, and thus afford fair starting-points for hybridising purposes. *Scolopendrium vulgare*, curiously enough, though extremely closely allied to the *Asplenia*, and capable, as we have seen, of a definite alliance with them, is, on the other hand, one of the most variable Ferns in the world, and hence, taking the varieties of this species and the tasselled forms of *Asplenium trichomanes* and *A. adiantum nigrum*, I would suggest systematic admixtures of the spores of these with a number of the plain-fronded exotic Asplenia, and particularly with *A. nidus avis.* This last has recently given us one curious wild semi-cristate sport, *A. n. a. multilobatum*, indicating great capacity for variation; and considering its extremely close agreement in structure with *Scol. vulgare* and the alliance above cited of this latter with *Asp. ceterach*, I feel confident that with perseverance we might not only obtain handsomely tasselled Bird's-nest Ferns, but also, in conjunction with some of the fertile forms of *S. v. crispum*, frilled ones as well. That beautiful Hartstongue, for instance, *S. v. laceratum*, with broad sagittate, tasselled basal lobes, deeply cut pinnatifid fronds, tasselled heavily at their terminals, would be a splendid mate, and the hybridist who mated the twain would certainly not repent the trouble taken. This field is a very wide one, but care would have to be taken to avoid all but thoroughbred symmetrical forms, since faults are almost certain to be transmitted and the progeny marred.

Asplenium trichomanes has, so far as I know, never yet been crossed or hybridised. *A. t. confluens*, Stabler, an asserted hybrid with *A. marinum*, does not bear the test of investigation, as *A. marinum* did not grow near the locality of origin; and although its spores are always imperfect, this is not enough to establish hybridity by itself. *A. trichomanes cristatum*, however, would be well worth sowing with other Asplenia, many of which are obviously very closely allied indeed. Our *Blechnum spicant* has given us some charming forms, crested, dissected, and otherwise varied. *B. s. cristatum*, *B. s. ramosum*, Kinahan, *B. s. trinervio-coronans*, Barnes, *B. s. concinnum*, Druery (strings of emerald scallop shells), *B. s. plumosum*, Airey, and others, one and all might find fit mates among exotic Blechnums and Lomarias, to many of which new charms would certainly be imparted, the twofold character of the fertile and barren fronds emphasising greatly the varietal features. Our Lastreas or Nephrodiums, and the exotic ones afford another field for combination as well as our marvellous Polystichums, of which the best plumose divisilobes are often sufficiently fertile to afford material. *P. setosum* especially should be tried with some of the best. Could thorough alliances be effected between this lovely lucent hard-fronded evergreen Shield Fern, and such gems as *P. a. cristatum* (Wollaston No. 10), *P. a. cristato-gracile*, Moly., and some of the divisilobe plumosums of Jones and Fox, Pearson and Esplan, the results could only be gems of first water.

Then there are our *Osmunda regalis* and *Osmunda japonica cristata* to act as suitors to *O. cinnamonea*, *O. interrupta*, and *O. gracilis*, and finally there are our lovely forms of *Polypodium vulgare*, *P. v. cristatum*, *grandiceps*, Fox, Forster, and Parker, *bifido-cristatum*, and *pulcherrimum*, to

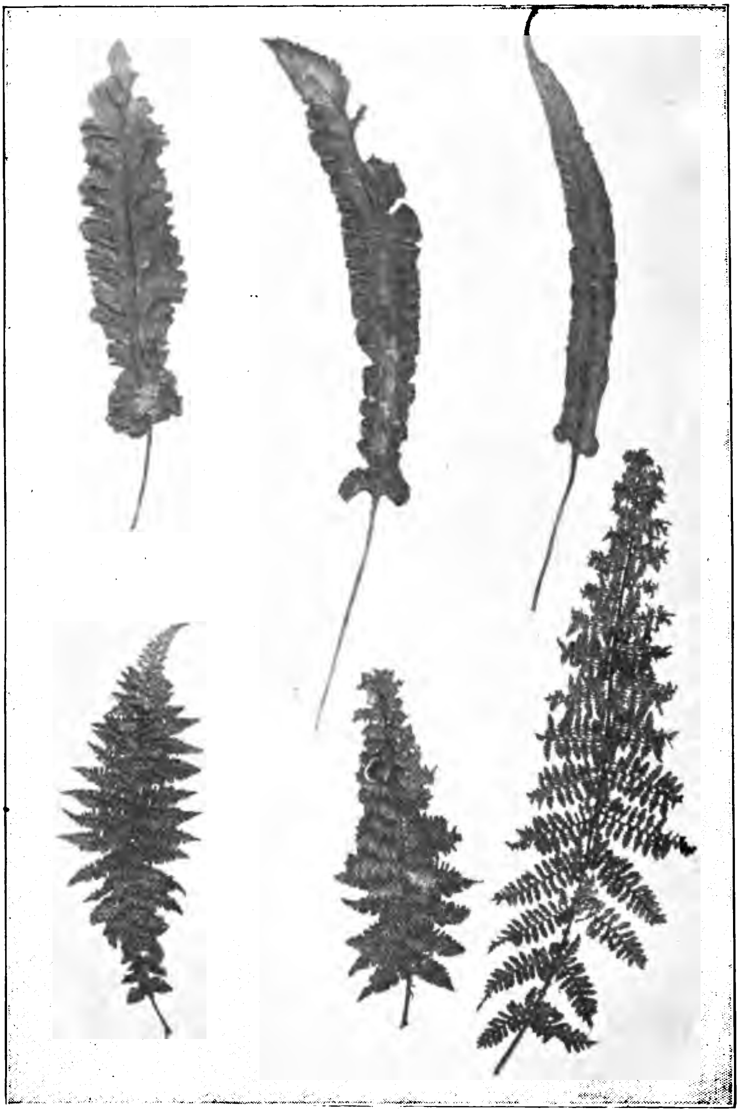
A A+B B

FIG. 110.—POLYSTICHUM ANGULARE ROTUNDATUM (A) × P. A. CRUCIATUM (B). RESULT OF THE CROSS (A + B).

Note that only the upper half of B is cruciate, and so with A + B.

say nothing of *P. v. elegantissimum*, the British-born parent of *P. Schneiderii*, all waiting for chances of the introduction which they certainly merit to the aristocratic Fern circles of their more stately foreign relatives. The field indeed is all but virgin, and I am confident

that careful cultivation of it would yield a host of new and charming novelties, provided—always provided—that it be done on right lines.



A A+B B

FIG. 111.—UPPER HALF: SCOLOPENDRIUM VULGARE CRISPUM FERTILE (A) × S. V. MURICATUM (B). RESULT OF CROSS (A+B).

LOWER HALF: ATHYRIUM FILIX FŒMINA CONGESTUM (A) × A. F. F. EXCURRENS (B). RESULT OF CROSS (A+B).

Into the question of simple crosses between varieties I do not propose to enter, space prohibiting, though to me and to British Fern specialists generally there is a wide and fertile field still but partly cultivated. I

have, however, framed my paper rather for the benefit of the more numerous raisers of exotics, who are too apt to ignore the merits of our home Ferns altogether, and only here and there recognise their value in the direction I have endeavoured to indicate.

In conclusion I may mention that there is one point in connection with Fern crossing which has no parallel in flowering plants, and that is the possibility of attempts being frustrated by apogamy. In numerous Ferns it has been found that the young plants are asexually generated in the prothallus, a simple bud arising on the spot usually occupied by archegonia. *Pteris cretica*, *Lastrea pseudo-mas cristata*, *Cyrtomium falcatum*, and others present this peculiarity in nearly every case, and of course under such circumstances no crossing is possible, unless in exceptional cases, where the normal process may obtain. As Cyrtomium and Lastrea, for instance, are closely related, and no crested Cyrtomium has been found, I sowed *Cyrtomium falcatum* and *C. Fortuneii* thickly with *L. p.-mas cristata*, obtaining a pure crop of both; a result I should have expected had I not forgotten the apogamous character of both members of the desired alliance. This, then, constitutes a hidden hindrance peculiar to Fern crossing. There are, however, a number of varieties of *Lastrea p.-mas* which afford extremely strong evidence of crossing, and I am therefore inclined to believe that apogamy in the species is by no means without exceptions, and that normal sexual reproduction frequently occurs.

Thanks to Mr. Alex. Wright, of South Norwood, I am able to present photographs of several of the crosses exhibited, viz.:—

Fig. 107. *Lastrea dil. lepidota* × *L. d. cristata.*

Fig. 108. *Polypodium vulgare*, var. *bifido-cristatum* × *P. v.* var. *elegantissimum.*

Fig. 109. *Polystichum angulare*, var. *polydactyla* × *P. ang. lineare.* N.B.—In this cross the defective polydactylism alluded to in the paper is seen and indicated by crosses.

Fig. 110. *P. angulare*, var. *rotundatum* × *P. ang. cruciatum.* N.B.—The rounded pinnules are not well shown in photo, but the normal outline of the lower part of the cruciate parent is preserved clearly in the cross.

Fig. 111. *Scol. vulg.* var. *crispum fertile* × *S. v. muricatum.* Result, a muricate *crispum.* *Athyrium filix fœmina*, var. *congestum* × *A. f. f.* var. *excurrens.* Result, a congested *excurrens*; a very striking cross; the hair-like terminal points of B and of A + B are hardly visible in the illustration.

HYBRID FERNS.

By Mr. H. B. MAY, F.R.H.S.

To the much debated question of the origin of hybrid Ferns I am afraid I cannot contribute much information, as although for a number of years I have endeavoured to obtain new varieties by sowing spores of different kinds together, and more especially with the Polypodies, in following the suggestions of my good friend Mr. Druery, it has been all to no purpose. Of the numerous varieties of Ferns that have originated in my nurseries—and they are many—I can only say that the whole of them are sports or natural hybrids.

Of the many Ferns from which I have obtained new varieties one of the most prolific, and perhaps the most erratic, is *Pteris Victoria*. This is thought by some to be a variegated form of *P. ensiformis*, an opinion to which I am unable to subscribe, as the green form of *P. Victoria* differs materially from that variety. From the first batch of sporelings raised from *P. Victoria* I obtained *P. regina*, *P. regina cristata*, *P. nivalis*, and, strangest of all, *P. tremula variegata*. This latter variety was also produced in Holland at about the same time, and this year a correspondent in the United States of America sent me fronds of *P. regina* and *P. tremula variegata*, which he had obtained from spores of *P. Victoria*. *P. tremula variegata* I have never been able to raise except from spores of *P. Victoria*.

Another Fern, very prolific in hybrids, is *Athyrium Waltoni diffusum*, one batch of sporelings producing *A. plumosum*, *A. tenellum*, *A. ornatum*, *A. Schneiderii*, *A. Hemsleyanum*, *A. elegantissimum*, and *A. microphyllum*. *Pteris tremula flaccida*, which I obtained from spores of *P. tremula*, was produced the same year at Hendon, and has been sent several times to the Floral Committee of the Royal Horticultural Society from different parts of the country, where it has appeared spontaneously.

HYBRIDS BETWEEN THE COMMON LILAC AND THE LACINIATED PERSIAN LILAC.

By MONSIEUR EMILE LEMOINE.

IN treating the question of hybridisation, there may be discussed either the technical processes designed to effect it, or the results which it may yield from the point of view of the improvement of living types. I propose to consider an accessory side of this subject by citing a case where the hybridisation has enabled us to assign to certain forms of vegetation their true placein the classification by throwing light upon their origin. I take the case of the obtaining of the Varin Lilac by crossing.

The common Lilac (*Syringa vulgaris*, L.), fig. 112, and its numerous varieties either with single or with double flowers, are reckoned among the most popular flowers and shrubs. Every garden, however small, contains several plants, and there is no man, however much a stranger he may be to natural things, who is insensible to the beauty and the perfume of these pretty spring flowers. By the side of these brilliant representatives of the genus, we meet with, though less abundantly, the more modest but no less interesting Persian Lilacs and the Varin Lilacs. I will not undertake to describe them, but will limit myself to citing the different forms generally cultivated, taking as guide the work, so complete, of M. Louis Henry, "Les Lilas au point de vue horticole." * The classification, which is given therein, corresponds with the ideas at present accepted by botanists.

The Persian Lilac (*Syringa persica*, L.), fig. 118, type of the species, has very slender stems, bent towards the soil, lanceolate leaves tapering gently to a point, and medium-sized flowers, hydrangea-rose coloured, arranged in long, loose inflorescences, scantily furnished, but very abundant.

This species, according to accepted ideas, has given birth to two varieties, the one called the white-flowered form (*Syringa persica alba*), fig. 113, the foliage of which is nearly identical with that of the type, but whose flowers are of a greyish white with a bluish throat. Another variety, the laciniated Persian Lilac (*Syringa persica laciniata*), fig. 114, is of an altogether different aspect: the plant is vigorous, with numerous thin branches, leaves sometimes entire, sometimes deeply laciniate, inflorescence numerous and well furnished with flowers of a bluish violet, with blue throat. It is by far the most widely distributed form of the group. "It is difficult," says M. Henry, "to consider it as the type of the species; the rose-coloured form is the best characterised. Until the contrary is proved we will admit it as typical." †

We will pass to the Varin Lilacs. So many names have been given to these that we have only *l'embarras du choix*. *S. chinensis*, Willd., 1796, *S. dubia*, Pers. 1802, *Lilac Varina*, Dum. Cours. 1802, *S. rothomagensis*, Mirb. 1804, &c. In France they are commonly called Varin Lilacs, and often, in error, Persian Lilacs. Amongst all these specific terms

* *Le Jardin*, 1894 and 1895.
† *Ibid.*, 1894, p. 200.

M. Henry chose that of *S. dubia*, Pers., which, in default of other advantages, has at least that of being but little compromising, and he cites :—

1. The Varin Lilac, or Rouen Lilac (*S. dubia* type), obtained in 1777

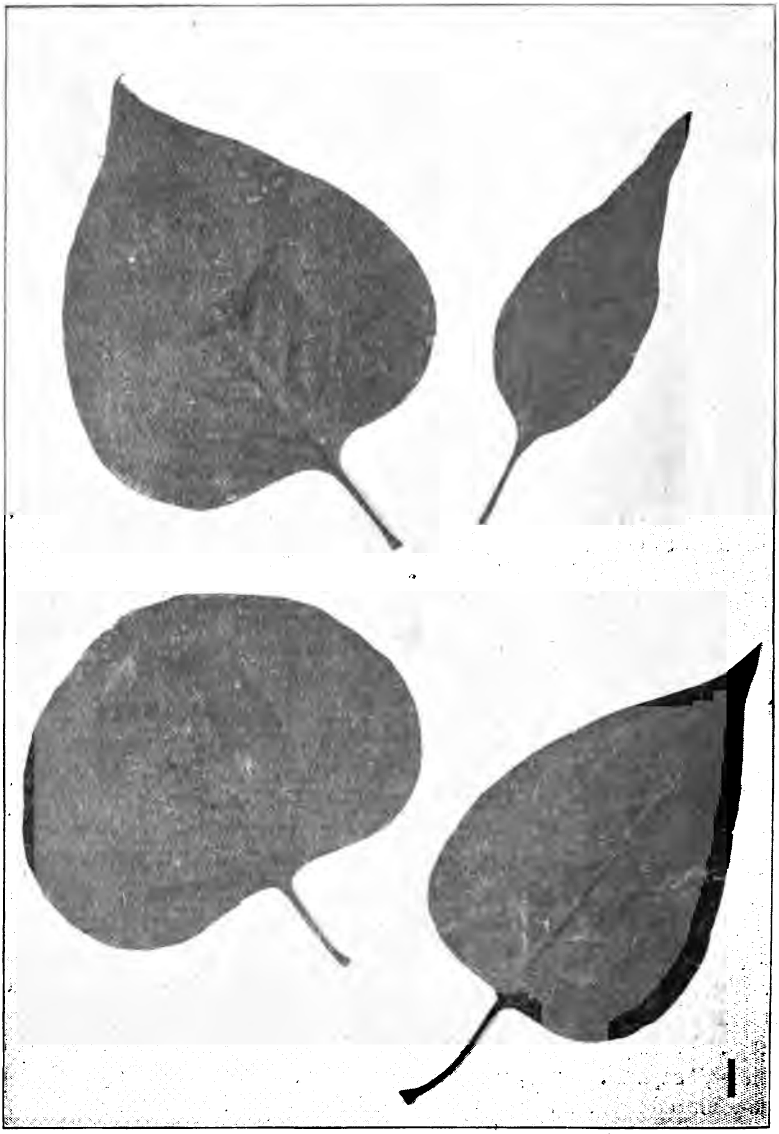


FIG. 112.—SYRINGA VULGARIS, L.
Leaves taken from extreme forms of the Common Lilac.

by Varin, a gardener at Rouen, with somewhat narrow and long leaves and numerous flowers, at first a reddish violet and then bluish.

2. The Saugé Lilac (*S. dubia Saugeana*), found in 1809, and dedicated to Saugé, son-in-law of Varin: it differs from the preceding, of which it

is probably only an accidental variation, in the purplish-red colour of its flowers.

3. The bi-coloured Varin Lilac (*S. dubia bicolor*), fig. 115, called also *S. rothomagensis bicolor*, and *S. rothomagensis alba*, with flowers of a

FIG. 113.—SYRINGA PERSICA ALBA.

slaty-grey with bluish violet throat: this is a fixed dimorphic form or "sport." In 1850 M. Victor Lemoine found at Noveant (old department of the Moselle), on the property of M. Guerber, an ordinary Varin Lilac, a branch of which bore nearly white flowers. It is this branch which, grafted and multiplied, was put into commerce by M. Lemoine under the name of *S. rothomagensis bicolor*.

4. The Metz Varin Lilac (*S. dubia* (*rothomagensis*) *metensis*), fig. 116. This is a sport with soft rosy lilac flowers observed by MM. Simon-Louis Frères upon a plant of the Saugé Lilac growing in the Place de l'Esplanade at Metz.

5. The Varin Lilac 'President Hayes,' fig. 117, has flowers of a deep metallic violet: it has been offered for sale by an American horticulturist, and its origin has not been indicated.

The origin of the Varin Lilac has been extremely contested. It suffices

FIG. 114.—SYRINGA PERSICA LACINIATA.

to establish this, to examine the different names given to it by botanists. Thus Willdenow thought that it was a native of China; many cultivators call it, again, the Persian Lilac. The majority have considered it to be a pure species; others have suggested that it might be a hybrid; it is also the opinion of M. E. A. Carrière, who has for a long time studied the small-leaved Lilacs, that it is a simple form of the common Lilac. M. Franchet follows him in this opinion, and calls it *S. vulgaris*, var. *dubia*.

Decaisne avows that he scarcely credits its hybrid origin. Baillon, consulted by Duchartre, says that he knows absolutely nothing about it. I read in the *Bon Jardinier* for 1864, compiled by Vilmorin, Poiteau,

FIG. 115.—SYRINGA DUBIA (VARINA, ROTHOMAGENSIS BICOLOR).

Bailly, Naudin, &c., in the article " S. Rothomagensis ": " It is said that this beautiful shrub has been found in a sowing of the common Lilac, made in Rouen by M. Varin; but it is a native of China, and constitutes a very distinct species." Twenty years previously the same publication

had stated it was a hybrid between the Persian Lilac and the Marly Lilac.

We have now seen how the question stands; the hybridising experiments which I have carried out will give us the reply.

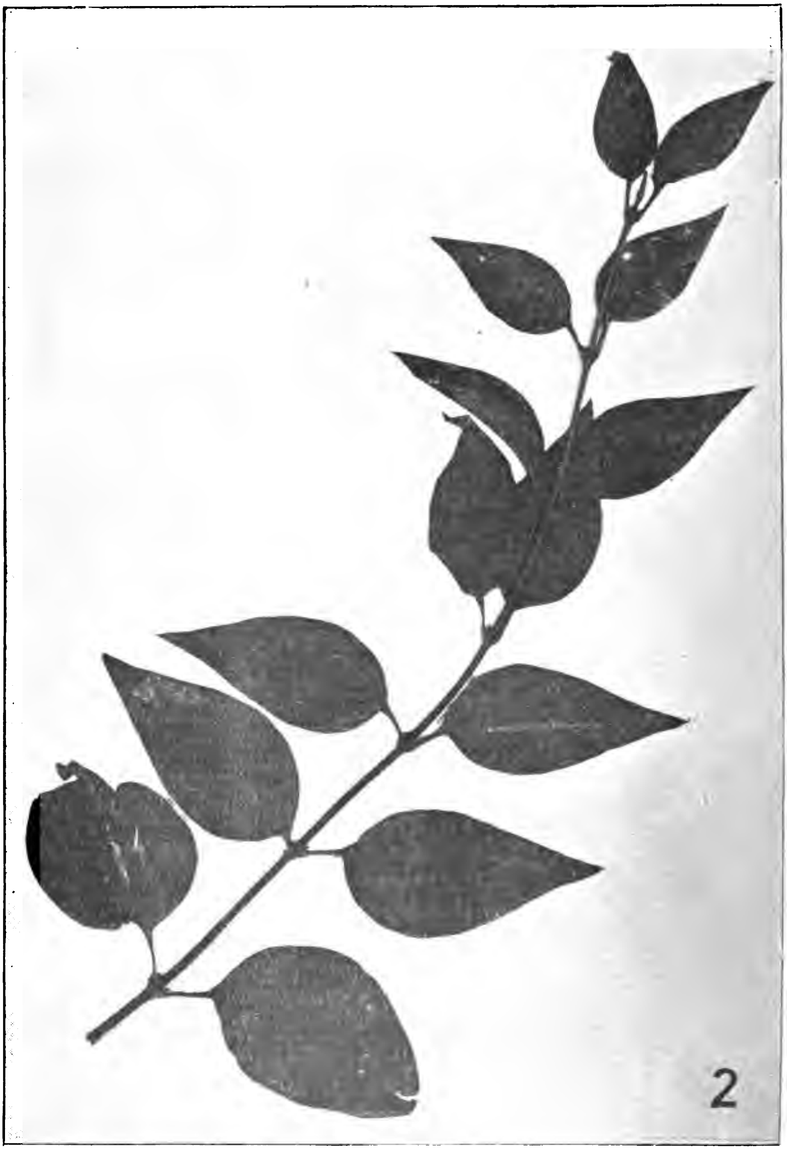


FIG. 116.—SYRINGA DUBIA (VARINA, ROTHOMAGENSIS) METENSIS.
The Metz Varin Lilac.

For a long time it has been my desire to obtain double-flowered Varin Lilacs. The first idea which occurred to me was to fertilise the flowers of a Varin Lilac with the pollen of the common double-flowered Lilac, or to

carry the pollen of a Varin Lilac to the flowers of the double Lilac. The attempt, renewed several years in succession, failed completely. I could never obtain a single seed of the Varin Lilac, and those which I got from the common Lilac had been fertilised, as experience subsequently proved,

FIG. 117.—SYRINGA DUBIA, PERS. (VARINA, ROTHOMAGENSIS) 'PRESIDENT HAYES.'

by pollen of the same species transported by insects. I knew that the Varin Lilac was generally considered sterile; I thus acquired the proof that its pollen was absolutely unfertile, while its pistil was equally

refractory as regards the action of the pollen of a neighbouring and perfectly normal species. This observation confirmed my idea which I had already conceived (now twelve years ago), viz. that the Varin Lilac,

FIG. 118.—SYRINGA PERSICA, L.
Showing one lobed Leaf.

figs. 115, 116, 117, was a hybrid, and that its parents were the Persian Lilac, fig. 118, and the common Lilac, fig. 112.

I chose then, as seed-bearers, the Persian Lilac type, fig. 118, with rose hydrangea flowers, and the Persian Lilac with whitish flowers, fig. 113;

and I repeated upon them and upon the common double-flowered Lilac, fig. 112, the work which I had previously attempted upon the Varin Lilacs. The failure was just as complete; I could not gather a single seed upon these two Persian Lilacs. I recommenced the following year, and I arrived at the same negative result. This led me to ask myself whether these two Lilacs, called Persian, figs. 113, 118, were not themselves also hybrids, the more so as I had never had occasion to remark a single case of fertilisation, either natural or artificial, on these two plants.

At the same time the laciniate Persian Lilac, fig. 114, the widest spread, the most vigorous, and the only naturally fertile one of the group, was submitted to the same experiment: all its flowers crossed with the pollen of the double Lilac, fig. 112, were fertilised perfectly and produced seed. A small number only germinated, and the young plants obtained presented in their vegetation and their foliage intermediate characters between those of the two parents. Nearly all the years after this first essay I continued to cross some bunches of the laciniate Lilac with the double-flowered varieties of the common Lilac. I have obtained at present about sixty plants of all ages, of which several have already flowered, figs. 119, 120. Some have given single flowers, others double and semi-double flowers. One of them has been sent out three years ago under the name of *Syringa Varina duplex*, fig. 121.

These plants form bushes of small height: the stems are slender; the leaves are narrow, lanceolate, lengthened, with certain slight differences as regards their width and length; often, even, there is seen at the base of the branches some leaves slightly lobed. In general they are narrower than in the common Varin Lilac, and little less lengthened than in the typical Persian Lilac. The inflorescence covers the upper part of the branches for a great length, just as in the Varin Lilac. The form of the flowers, whether single or double, is also analogous to that of the Varin Lilac. The colours obtained until now range from violet-tinted lilac to purplish lilac and bluish lilac. I have therefore realised experimentally the Varin Lilacs perfectly characterised and bearing the living imprint of the hybridisation which has produced them by their flowers, often double, and by their leaves, somewhat lobed.

The Varin Lilac is therefore not the Chinese Lilac of Willdenow, nor is it the 'doubtful' Lilac of Persoon. It is a hybrid between *S. persica laciniata*, fig. 114, and *S. vulgaris*, fig. 112, and no other appellation can be attributed to it than that given by Dumortier in 1802, *Lilac* (or *Syringa*) *Varina*, in honour of Varin, with whom the cross has operated for the first time in Europe, by chance, aided by the wind and by insects.

Following up this result, now perfectly established, I will permit myself to formulate several hypotheses, which appear to me infinitely probable.

The Varin Lilac type, obtained by Varin himself, should be the only plant of this group obtained from seed. The other forms, *Saugeana*, *bicolor*, *metensis*, &c., have been obtained by dimorphism (or sport) either from the Varin Lilac type or later from the Saugé Lilac.

It is very probable that this Varin Lilac type, of which the leaves are wider than those of any hybrids, has been produced by the fortuitous

fertilisation of the common Lilac ♀, fig. 112, by the laciniate Persian Lilac ♂, fig. 114, since Varin has only thought of sowing seeds of the common Lilac. It would therefore be a hybrid inverse to mine, and this

FIG. 119.—SYRINGA (DUBIA) VARINA, fl. pl. No. 12.
Raised by Monsieur Lemoine from S. persica laciniata ♀ × S. vulgaris ♂.

FIG. 120.—SYRINGA (DUBIA) VARINA, fl. pl. No. 10.
Raised by Monsieur Lemoine from S. persica laciniata ♀ × S. vulgaris ♂.

difference of origin would be translated into a difference of width in the leaves.

Another hypothesis which appears to me to be perfectly justified. The laciniate Persian Lilac, fig. 114, is the true type of the species: its habit, the form of its leaves, its inflorescence, its odour (but little agreeable),

FIG. 121.—SYRINGA (DUBIA) VARINA DUPLEX.
Raised by Monsieur Lemoine from S. persica laciniata ♀ × S. vulgaris ♂.
Showing the occasional occurrence of lobed Leaves.

are absolutely typical characters. Furthermore it is regularly and naturally fertile.

It appears to me very difficult to admit that the two other forms of the Persian Lilac, of which one, that with rose-coloured flowers, has been up to now considered the type of the species, fig. 118, are varieties

raised from seed of the laciniate Lilac; their sterility, absolute or nearly absolute, can scarcely be understood in this case. I have heard them qualified as sports. It appears to me indeed probable enough that the variety with whitish flowers (*S. persica alba*), fig. 113, arises by dimorphism from the rose-coloured variety, because it is identical with it in all parts, and only differs in the hue of its flowers. But I do not admit that the rose-coloured variety arose in the same fashion from the laciniate type, because the dimorphism generally affects only one character, form or colour of the foliage, form or colour of the flowers, for example, but not the whole of the characters at once. Now the Lilac called the Persian Lilac is profoundly different from the laciniate Lilac in all respects. I consider it as a spontaneous hybrid between the laciniate Lilac and the common Lilac, that is to say, that it should belong, as well as the white flowered form derived from it, to the section of Varin Lilacs.

If we compare the foliage of the various forms enumerated here, it will be remarked that the laciniate Lilac, fig. 114, on the one part, and the common Lilac, fig. 112, on the other part, are extremely different from each other, while the Varin Lilacs, Saugé, bicolor, and Metz Lilacs obtained by artificial crossing between the common Lilac and the laciniate Lilac, and finally the Lilacs called Persian with rose flowers and white flowers, present the greatest resemblance to each other.

To sum up, this is the conclusion to which we are led by the hybridisation. We have to do with two widely separated species, the *Syringa vulgaris* and the *Syringa* (*persica*) *laciniata*. Between these two types we find a whole series of hybrid forms or sports of hybrid forms by dimorphism. The Varin Lilac and its varieties are but an item in this series of the same class as those I have produced by synthesis, and probably also of the same class as the Lilacs called rose-flowered and white-flowered Persian Lilacs.

HYBRIDS AND CROSSES OF CLEMATIS.

By Monsieur F. MOREL.

THE present constitutes a simple report of hybridising experiments which I have made and the results obtained.

CLEMATIS COCCINEA × C. PITCHERI.—The first attempts to cross these two plants of the same group (*coccinea* and *Pitcheri*) succeeded entirely, producing a great number of fertile seeds. *C. Pitcheri* was taken as the carpellary, or seed-bearer, and *C. coccinea* furnished the pollen.

The progeny is remarkable for the resemblance of all the individuals to each other, constituting a new form intermediate between the two species whence it originated.

The *Revue Horticole* of August 16, 1893, has published, under the signature of M. Ed. André, a description of this hybrid with a coloured figure, which represents it accompanied by its two parents.

It derives from *C. coccinea* its precocity of flowering, its beautiful carmine colour, more or less tinged with violet, and from *C. Pitcheri* its vigour, the bushy stems, and the sepals, which are more open and a little reflexed at their tips. The flowers have a sweet odour of vanilla. The plant seeds abundantly and naturally, and reproduces itself almost exactly; but if the pollen of one of the parents be again introduced there result a great number of forms which depart from the plant pollenised afresh and approach the pollen parent.

The curiously abundant fertility of the Clematis obtained by crossing *C. Pitcheri* and *C. coccinea* appears to indicate that these two plants, so different in aspect, belong, however, to one and the same specific type, and are but forms widely differentiated of one species, which occupies large areas, and under conditions of climate and environment sufficiently diverse to have given rise to local races presenting all the appearance of specific autonomy.

NO. 378.—HYBRID BETWEEN '*C. COCCINEA*' AND A '*CLEMATIS MEGALANTHA*,' NO. 140 (WITH LARGE FLOWERS).

In this instance the hybridisation was effected between two species of very different groups. The large-flowered Clematis No. 140 (unnamed as yet) was pollenated by *C. coccinea*. This latter has conveyed the form of the flower, the consistence and the number of the sepals (four regularly) which form a tube for about one-third of their length, opening then funnel-fashion by gradually separating themselves, and are reflexed outwards at the tips, a form intermediate between the urceolate form of *C. coccinea* and the large wide-spreading flowers of Clematis No. 140. This latter has given the colour, lilac-rose striped with deeper rays, outside yellowish-white, on the inside having a little of both parents. The leaves resemble more those of a large-flowered Clematis than those of a *coccinea*. Despite all attempts to obtain seed, this hybrid has so far remained sterile.

No. 401.—Hybrid between the large flowered Clematis 'Oriflamme' and 'C. coccinea.'

Here, again, it is *C. coccinea* which has furnished the pollen. The hybrid has preserved nearly all the characters of vegetation, foliage, shoots, and buds; but the flower opens with a widened tube, and the sepals, thick and fleshy, of a violet-purple colour dotted with darker points, are variable in number, sometimes four, as in *coccinea*, sometimes five and even six, as in the Clematis 'Oriflamme.'

This hybrid is almost sterile.

Clematis 'Ville de Lyon,' Described and Figured in the "Revue Horticole" of April 16, 1899.

This marvellous plant is without a doubt one of the most beautiful which has been obtained in the Clematis species. It is principally on account of this plant and in order to exhibit it to those taking part in the Conference that I am here; and it really seems to me the most worthy of that honour among all those which I bring to the notice of this assembly.

Its hybrid origin is not doubtful if we consider its actual birth. This testifies that it is the product of an artificial fecundation effected with the aid of pollen of *C. coccinea* upon a large flowered Clematis named 'Viviand Morel,' a variety not yet in commerce.

At first sight the general aspect of the plant seems to belie this origin: the foliage is altogether that of a large flowered Clematis, the flowers well opened in broad rosettes, with edges scarcely raised at all, not recalling in any way the thick sepals, more or less urceolate, of *C. coccinea*, the preceding hybrids of which had partially retained their arrangement and form. Is it possible that we have here to do with an illegitimate child, and that, despite the Latin adage, the father is not the one the nuptials indicate? It is rash to be too sure; so many causes could favour an irregularity: the wind, the insects to which some adventurous pollen grain had confided its fortunes. Nothing further is necessary.

Other characters, however, are more encouraging, without speaking of the rich crimson colour of the flower, which certainly appears to be derived from *C. coccinea*: this species also appears in the form, the number, and the arrangement of the stamens, and above all in the constitution of the plant, to which it seems to have imparted its immunity from the terrible malady of the large flowered Clematis, and to have transmitted, on the other hand, its susceptibility to the *oidium*, or "white," of the Clematis family. This last disease is in fact that against which it is most necessary to guard, but, as is well known, it is not difficult to do so.

Besides these I know of other cases of hybridisation where the product is in no way intermediate between the parents, and only resembles one of them, without, however, making me doubt their origin at all. The most striking of these is that of a Pæony raised by the artificial fecun-

dation of *Pæonia officinalis* by *P. Russi.* The plant produced from this hybridisation entirely resembles *P. officinalis,* from which it is only and scarcely distinguishable by a few scattered hairs, whereas *P. officinalis* is perfectly glabrous, no other character revealing the influence of the male parent. The plant, however, is certainly a hybrid, and as evidence thereof remains always sterile. May it not be so with the Clematis 'Ville de Lyon'?

FIG. 122.—URCEOCHARIS CLIBRANI (*Journal of Horticulture*).
(Eucharis grandiflora (amazonica) × Urceolina pendula.)

HYBRID CLEMATIS.

By Mr. A. G. Jackman, F.R.H.S.

The hybridisation of the Clematis can be traced back to sixty-four years ago, the earliest successful attempt being made by the late Mr. Henderson, of Pine Apple Nursery, in 1835, who raised C. Hendersoni, which was at that time considered a great acquisition. Its parents are supposed to be C. Viticella and C. integrifolia.

A few years after this saw the advent of C. patens from Japan, which may be taken as the type of the large spring-flowering Clematises, followed by C. Amalia, C. Louisa, C. Monstrosa, and C. Sophia, all of them being varieties of C. patens.

It is to Fortune that the horticultural world next became indebted for sending over from China in 1851 that grand plant, C. lanuginosa, and in 1863 C. Fortunei and C. Standishii, as it is from these three and C. patens that the magnificent large-flowered varieties have been obtained.

The first person to take up the hybridisation of the aforementioned species in this country was Mr. Anderson-Henry, of Edinburgh, who in 1855 crossed C. patens with C. lanuginosa, the result being a handsome lavender-coloured variety named C. Reginæ.

After this came the ever-popular Woking hybrid C. Jackmanni, raised in 1858, which, with C. rubro-violacea, C. Prince of Wales, C. rubella, C. magnifica, C. Alexandra, and C. velutina purpurea, all dark-flowering varieties, were the result of crossing C. lanuginosa by C. Hendersoni and C. Viticella atrorubens. Some of these varieties were afterwards crossed with C. lanuginosa, producing several dissimilar varieties, viz.: C. Mrs. James Bateman, pale lavender; C. Beauty of Surrey, light greyish blue; and C. Lady Bovill, greyish blue; also C. Sir Robert Napier, a rich purple, and C. Thomas Moore, a rich puce-violet.

Following these another batch of seedlings was raised at the Woking Nurseries, and first flowered in 1871, from intercrossing C. patens, C. Fortunei, C. Standishii, and C. Sophia plena, with C. Jackmanni, C. rubella, C. rubro-violacea, and C. magnifica, and also reversing the crossings, some of the offspring partaking of the parents of the patens type, whilst the others took the character of the parents of the Jackmanni and Florida types. Those which partook of the patens type showed great variety of colour, amongst them being C. Fair Rosamond, blush white with wine-red bar; C. Edith Jackman, blush white with broad purplish-rose bar; C. Vesta, white; and C. The Queen, delicate mauve; these four varieties being also sweet scented, which is supposed to be derived from C. Fortunei. There were also C. Lord Derby, bluish mauve; C. George Cubitt, pale lilac mauve; C. Lord Mayo, deep rosy

lilac; and C. Stella, pale violet with plum-red bars. Of those of the Florida type are C. Countess of Lovelace, bluish lilac with double Anemone-formed flowers; and C. Unique, pale yellowish green. Amongst those which took the character of the Jackmanni type are C. W. E. Essington, a reddish violet; C. Marquis of Salisbury, a dark plum colour; and C. Lady Stratford de Redcliffe, a slaty lilac.

Still further improvements were made, after these at the Woking Nurseries, in the lanuginosa type, notably C. alba magna, which in my opinion is the finest white in cultivation; C. Mrs. Hope, a beautiful satiny mauve, and C. Blue Gem, a pale cærulean blue, both being bred between C. lanuginosa and C. Standishii; also C. Princess of Wales, a deep bluish mauve; C. Robert Hanbury, a bluish lilac; and C. Duke of Norfolk, a deep mauve.

I might here mention that among batches of seedlings there are generally several which partake too much in colour and general character of one or other of the parents, or are too near other varieties in cultivation, to be of any use.

Among the foremost hybridisers of the Clematis must also be mentioned Monsieur Lemoine, of Nancy, who has raised several good varieties of the patens, lanuginosa, and Viticella types of recent years, more especially of the Viticella type, conspicuous among them being C. candidissima plena, C. Florida pallida, and C. Vestale, of the first type; C. lanuginosa candida, C. lanuginosa nivea, C. Otto Froebel, and C. La Gaule, of the second type; C. Monsieur Grandeau, C. Kermesina, C. La Nancienne, and C. Madame Moser; and the fine double-flowered variety C. Lucie Lemoine, of the Florida type. He is also to be credited with several varieties of the herbaceous race.

Next come Messrs. Simon Louis, of Metz, their earliest varieties being likewise improvements on C. patens, viz.: C. Louisa plena, C. Clara, and C. Marie; they afterwards brought out C. splendida, C. fulgens, C. perfecta, and C. nigricans, the first two being raised from C. lanuginosa crossed with C. Viticella grandiflora.

Messrs. Cripps & Son have also introduced several good varieties, principally of the lanuginosa type. I am not acquainted, however, with any specific crosses they have made, but amongst the varieties raised by them, C. Lady Caroline Nevill, C. Madame van Houtte, C. Tunbridgensis, C. Star of India, and C. Fairy Queen still retain honoured places in good collections.

Another eminent hybridiser is Mr. Charles Noble, who has raised several varieties, principally of the patens type, from the intercrossing of C. Standishii and C. Fortunei, chief amongst them being C. Albert Victor, C. Miss Bateman, C. Lady Londesborough, C. Lord Londesborough, and C. Mrs. Villiers Lister.

Other names associated with the fertilisation and improvement of the Clematis are: Messrs. G. Baker & Son, who raised C. Gem from C. lanuginosa crossed with C. Standishii, which is almost identical with C. Reginæ, raised by Mr. Anderson Henry some years previously, as already mentioned:—Messrs. Richard Smith & Co., who raised C. Beauty of Worcester and C. Snow White Jackmanni:—Mon. Briolay-Goiffon, who raised C. Aureliana from C. patens crossed with

C. lanuginosa:—Mon. Rinz, of Frankfort, who obtained C. Francofurtensis from C. patens crossed with C. Viticella cærulea:—Mon. Carré, of Saint-Julien, who introduced C. Gloire de St. Julien and C. Impératrice Eugénie, the result of crossing C. monstrosa plena with C. lanuginosa pallida:—Mon. Dauvesse, of Orleans, who raised C. Jeanne d'Arc from C. patens crossed with C. lanuginosa:—Mon. Modeste-Guérin, who sent out C. modesta, from C. lanuginosa crossed with C. Viticella, and C. purpurea hybrida:—Mon. Christen, of Versailles, who raised C. Etoile de Paris, C. La Géante, and C. Madame Furtado-Heine, the latter being a cross between C. Viticella rubra grandiflora and C. lanuginosa:—Mon. F. Morel, of Lyon Vaisse, who introduced C. Etoile Violette, C. François Morel, and C. Perle d'Azur, and has recently raised several new varieties of the Viticella type:—Mon. Baron Veillard, who obtained C. Madame Edouard André by crossing C. Jackmanni with C. patens, and C. Madame Baron Veillard:—and Mon. Gegu of Angers, who raised C. La France by crossing C. lanuginosa with C. Jackmanni.

Nearly all the varieties mentioned as having been raised in this country were obtained previous to 1880; since then the introduction of really sterling new varieties has been almost nil—in fact, successful hybridisation or cross-breeding of the Clematis appeared to be practically at a standstill for about twelve years, until it was revived by the introduction of my new race of hybrids, which were obtained by crossing C. coccinea, one of the small American species from Texas, with the large-flowered garden varieties, the former being the pollen parent. This cross had previously been tried in reverse order without any result. There were, I think, two reasons for this falling-off in the raising of improved varieties of hybrids. It was due mainly, I think, to the want of fresh blood on and with which to work. Hybridising and intercrossing amongst the large-flowered species and their hybrids—including not only an almost overwhelming number of varieties of nearly all shades of white, mauve, lavender, lilac, blue, purple, and violet, but embracing a continuous flowering season from May to October—had been carried on to such an extent that it became very difficult, if not impossible, to obtain anything really distinct. Secondly, the only too well known "dying off" amongst the Clematis rendered cross-breeding very disappointing, as unless great care was taken in selecting robust parent plants which had not shown any signs of this "dying off," failure and disappointment would most probably ensue, either in the loss of the seed-bearing parent, or in handing down to the offspring the evil which had been engendered in the parent.

The cross-breeder, before starting to work, should first decide upon what qualities or points he wishes to develop in the offspring, and see that at least one or both of the parents possess similar characters, and that, besides being of sound and robust constitution, they have flowers of good form and habit for their respective types; the latter is a point which has often struck me as being wanting, especially in some of the continental varieties, so many of them having long and narrow sepals, giving a decidedly weak and starry appearance to the flower.

I have noticed from time to time the different opinions expressed,

through the press, upon the cause of this "dying off," the most recent being by certain continental gentlemen in "The Garden" of February 18, 1899, in which Messrs. Goos & Koenemann give their opinion that it is caused by the bursting of the cells through excessive moisture. Mr. J. Nicolai believes it to be caused by injury from frost; Mr. C. A. Meyer thinks it is brought about by too rich food or too much water; and Professor Dr. P. Soraner, that too much water, nourishment, and heat are the cause. All these gentlemen are to a certain extent right, as there is no doubt in my mind that frost is the cause in some cases, too much water and bad drainage in others; but in my opinion they have not yet arrived at the principal reason, as I have seen plants affected which have never been touched by frost. And my experience is that plants mostly go off during the summer months, when the ground is driest and the temperature hottest; and in most of these cases I could not detect any sign of the plants having had too much moisture, or that the drainage was bad. In addition to this, the collapse often comes after the plant has made several feet of growth, and is forming the flower buds; which to me seems to imply that its vital power had been expended, the result being a speedy and total collapse. Besides, if the reasons given by these gentlemen are the only and right causes, how is it that this "dying off" was not noticed twenty-five and thirty years ago, and why should it have increased of recent years? Again, how is it we do not see the rampant robust growths each year which there used generally to be? Putting on one side for a moment the fact that the Japanese and Chinese species have not the stamina of some of the European, American, and other species, there seems to me but one answer to all these queries—viz. that the Clematis is suffering from *loss of constitution* through *over-propagation*; and that is, in my opinion, to a great extent the cause of the "dying off," for it has been conclusively proved that neither insects nor fungi are responsible for it. Assuming that this is correct, we have at once the cause of some of the disappointments and failures in raising new hybrids in past years, and the reason why several of the newer varieties are affected in the same way.

With regard to the new race of coccinea hybrids already mentioned, several seedlings have been raised, from which I have at present selected the following varieties, showing great diversity in colour and form from any other hybrids, as well as improved constitution, which were the objects aimed at in making the cross. They are C. Countess of Onslow, a bright violet purple; C. Duchess of Albany, a beautiful bright pink; C. Duchess of York, a pale blush pink; C. Grace Darling, a bright rosy carmine; C. Sir Trevor Lawrence, a bright crimson; and C. Admiration, a rich magenta purple. These new varieties also lay claim to profuse and successional blooming properties, more graceful habit, greater substance in the sepals of the flowers, which, in conjunction with their being produced on long peduncles, renders them of great use for decoration.

The following is a table of several specific crosses made between species, and species and hybrids. Unfortunately no records have been kept of the parents of several of our best hybrids; consequently I am unable to trace the improvements made to any great extent.

I will commence with

C. patens (mauve lilac) × C. lanuginosa (pale lavender)

producing C. Aureliana, porcelain blue;
C. hybrida Andegavensis, dark blue;
C. Baraillet Deschamps, mauve;
C. Reginæ, lavender blue;
C. Jeanne d'Arc, greyish white;
C. Otto Froebel, greyish white;
C. lanuginosa nivea, white;
C. lanuginosa candida, white;

the first two partaking of C. patens; Baraillet Deschamps, which is a double-flowered variety, being classified amongst the Florida type; and the last five, which are all whites with the exception of C. Reginæ, resembling C. lanuginosa.

Next we have

C. lanuginosa nivea (white) × C. lanuginosa (pale lavender)

yielding C. Duchess of Teck, white;
C. Duke of Richmond, lavender grey;

and C. lanuginosa nivea (white) × C. Standishii (light blue mauve)

producing C. Earl of Beaconsfield, deep mauve;

also C. lanuginosa candida (white) × C. Standishii (light blue mauve)

giving us C. Florence, pale mauve;

all of these pertaining to the lanuginosa type. And from

C. lanuginosa candida (white) × C. Fortunei (creamy white)

we have C. Mrs. George Jackman, white;
C. Belle of Woking, silvery grey;
C. Petrarch, creamy white;

the first belonging to the patens type, but continuing in flower much later than most of that type; the second partaking of C. Fortunei, and classified under the Florida type; and the last being of the lanuginosa type.

Next, from C. patens (mauve lilac) × C. Fortunei (creamy white)

is derived C. Lucie Lemoine, white,

a double variety of the Florida type.

From C. patens (mauve lilac) × C. Viticella (bluish, purple, or rose)

we find C. Guascoi, deep purplish violet;

and from C. patens (mauve lilac) × C. Viticella cærulea (blue)

we have C. Francofurtensis, deep purplish blue;

both of the Viticella type.

Also, from C. patens (mauve lilac) × C. Jackmanni (violet purple)

we have C. Sabrina, pale lavender;
C. Lord Lytton, bluish purple;
C. The Kelpie, grey;
C. The Kelpie's Bride, white;
C. Mdlle. Torriani, solferino pink;
C. The Czar, purple;
C. The President, dull violet;
C. Madame Edouard André, dark red;

these, as will be noticed, showing great diversity of colour—the first five partaking of the parent patens, and the last three of the parent Jackmanni.

I will next take the other crosses made with C. lanuginosa. First we have

C. lanuginosa (pale lavender) × C. Fortunei (creamy white)

giving us C. Mrs. G. Mitchell Innes, pale lilac mauve;
C. Thomas Tennent, French white;
C. Mrs. Melvill, pale mauve;
C. Symeana, pale mauve;
C. Henryi, white;
C. Lawsoniana, rosy purple;

the first two resembling C. Fortunei, and therefore classed under the Florida type, and the last four partaking of C. lanuginosa.

Next we have

C. lanuginosa (pale lavender) × C. Standishii (light blue mauve)

producing C. Duke of Norfolk, deep mauve;
C. Blue Gem, cærulean blue;
C. Gem, deep lavender;
C. Mrs. Hope, satiny mauve;

all of these clinging to the parent C. lanuginosa. Then

C. lanuginosa (pale lavender) × C. Viticella (bluish purple or rose)

yielding C. Viticella amethystina, pale violet blue;
C. Viticella pallida, lilac;
C. Modesta, bright blue;
C. Madame Grangé, deep maroon crimson,

all of the Viticella type;

C. lanuginosa (pale lavender) × C. Viticella grandiflora (blue)

giving us C. fulgens, dark mulberry purple;
C. splendida, rich reddish violet;

being intermediate between the two parents, and classified under the Jackmanni type; and

C. lanuginosa (pale lavender) × C. splendida (rich reddish violet)

producing C. lanuginosa perfecta, violet mauve.

Next, from

C. lanuginosa (pale lavender) × C. Viticella rubra grandiflora (claret crimson)

we have C. Madame Furtado-Heine, satiny rose,

also intermediate between the two parents, and classified with C. Jackmanni.

From C. lanuginosa (pale lavender) × C. Jackmanni (violet purple)

we get C. La France, deep violet blue,
C. Reine des Blues, blue,

both of the lanuginosa type. And from

C. lanuginosa (pale lavender) × C. rubro-violacea (maroon purple)

we have C. lanuginosa violacea, bluish purple.

Also, from C. lanuginosa (pale lavender) × C. Fair Rosamond (blush white)

we find C. Ville de Paris, flesh-coloured white,

likewise of the lanuginosa type.

Then we have

C. lanuginosa pallida (pale lavender) × C. monstrosa plena (white)

producing C. Gloire de St. Julien, French white,
C. Impératrice Eugénie, pure white,

both of the lanuginosa type;

C. Fortunei (creamy white) × C. Standishii (light blue mauve)

yielding C. Princess Mary, pale pink,

of the patens type;

and C. Fortunei (creamy white) × C. Jackmanni (violet purple)

giving us C. Xerxes, dark violet;
C. Zanoni, mottled lilac;
C. Jackmanni alba, greyish white;

all of them belonging to the Jackmanni type.

Next we have

C. Standishii (light blue mauve) × C. Jackmanni (violet purple)

producing C. Earl of Egmont, deep reddish purple,
C. Mdlle. Albani, pale lilac mauve,

both of the latter type. And from

C. Standishii (light blue mauve) × C. John Gould Veitch (lavender blue)

we have C. Lady Alice, deep lilac mauve;
C. Margaret Dunbar, deep purplish lilac;
C. Elaine, violet blue;
C. Undine, rosy lilac.

the first two belonging to the patens type; the other two, which are doubles, being classified under the Florida type.

ON THE CROSSING OF 'ANTHURIUM SCHERZERIANUM.'

By Monsieur DUVAL.

IT may be said, without fear of contradiction, that the beautiful varieties of 'Anthurium Scherzerianum,' which are so justly admired at the present day, are entirely the work of horticulturists.

Indeed, there has been no intervention whatsoever at any time of any more or less perfect species or variety to contribute towards improving the type, introduced about the year 1860 by Scherzer, and of which I am still in possession of an authentic specimen.

With the exception of the Anthurium Scherzerianum with white spathes, known under the name of 'Williamsii,' and which, it is stated, was used to fertilise the red variety which produced Anthurium Rothschildianum, I do not see that the raisers have had any elements other than those of which I am going to speak.

If there have been (which is possible) better and worse varieties imported, they have all, at all events, been greatly improved by repeated sowings and careful selection. Messrs. Veitch, Van Houtte, Linden, Bergmann, Bleu, and more especially Bertrand, an amateur of Queue-en-Brie, Seine-et-Marne, have largely contributed towards improving and perfecting Anthurium Scherzerianum; and so at a later date have Messrs. De la Devansaye and Truffaut in France, De Smet Duvivier in Belgium, and lastly myself, my attempts dating back to 1882.

It is but very gradually that one can succeed in changing the form of Anthurium Scherzerianum when one possesses only such very limited resources. It is difficult to get the first 'break,' and it is only by dint of perseverance and proper selection that one can materially alter these plants, *i.e.* give them beautiful foliage and fine, brilliantly coloured spathes, possessing the property of lasting well.

What did we possess in 1882 in order to work on the Anthuriums with red spathes? A fine variety sent out by Messrs. Veitch under the name of Anthurium Scherzerianum Wardianum, and subsequently a white-spathed variety named 'Williamsii.'

I purchased an Anthurium Scherzianum Wardianum, and it is by means of the pollen of this plant and a few specimens picked up at the late M. Bertrand's sale that I began to hybridise and make sowings. I was fortunate at the commencement, for in 1891 I sold to M. Auguste Van Geert a splendid variety, under the name of 'President Carnot,' which has never been surpassed for the size and beauty of its foliage and whose dark cerise-coloured spathes are almost round.

But in 1889 I previously showed some Anthuriums, with blood red and violet red spathes, of which one plant, 'Sang Gaulois,' was to become the departure of a whole series of very dark varieties, with spathes of excellent form.

I then fertilised the plant 'President Carnot' with a white Anthurium, and I had the satisfaction of raising a plant which we named 'La France.' The spathe of this variety is dark red underneath

and bluish white above, with markings of a vermiculate appearance, drawn horizontally. It is nearly round, and is therefore quite distinct in character from the types 'Rothschildianum.' It may be said that the Anthurium 'La France' is absolutely a special type.

But now let us enter more into the question of fertilisation, and see what are the chances of being able to cross-fertilise Anthurium Scherzerianum. They are of various natures, for it is quite obvious that it is not a question of selecting a grand flower, and placing on the female organ the pollen of a selected anther. It is necessary to proceed very differently, since we have to deal with a spadix bearing a large number of perfect flowers. However, by proceeding with precaution and examining with a strong lens the state of the flowers on the spadix, and ascertaining that if the female organs are ready to receive the pollen the male organs are not yet in a state to mix their pollen with what one desires to introduce, one can then, with the aid of a fine-pointed camel's-hair brush, take some pollen from the spadix of the chosen male plant and convey it gently to that of the female plant.

This operation must be performed in fine weather and out of the damp; but it is certain that it only gives a comparatively small chance and that nine times out of ten the pollens will get mixed. It is therefore difficult, if one does not know the genealogy of his plants well, to assert that one variety has had an influence on another. It is only on the flowering (to use the horticultural expression) that one will be able to ascertain if there has been any intervention of the selected male, or to what extent it has taken place.

A very curious fact I have observed in the Anthurium Scherzerianums, obtained by crossing white-spathed varieties with red-spathed ones, is that should the result produce some plants having spathes of salmon or reddish tints, others having very dark red spathes are dotted with pure white, principally on the upper surface, and, examined through a lens, appear to be altogether flecked with myriads of little white spots.

There are still many interesting things to be noticed concerning the process of fertilisation in Anthuriums. Certain plants owe the colour of their spathes to a sort of dimorphism; the colour is not constant, and may vary very much. A plant may one year produce spathes streaked or dotted with salmon, and another have them nearly all of one colour. It is therefore advisable not to fertilise plants with similar varieties, as considerable risk is run of not getting anything of any stability. It is also essential to take account of the substance of the spadix, its length, &c., and also of the substance of the spathe, which will be much finer if it is thick, and does not show any tendency to lose its colour quickly.

Some varieties, such as Parisiense Madame Dalière, have bright pink spathes. It is curious to notice that their intervention in the fertilisation of red-spathed varieties acts exactly like mixing colours in painting, as carmine lake mixed with white and vermilion produces salmon. The reverse operation gives, on the contrary, a large proportion of red-spathed plants, always, in my opinion, owing to the preponderating influence of the more intense colour.

A great deal still remains to be said about Anthurium Scherzerianum,

but a paper must have limits, and I consider it advisable to limit myself to matter of a nature to furnish information.

I do not pretend to lay down any rigid rule or absolute formula in what I have said. I speak from notes taken in the course of my operations, and am open to correction. My opinions may be summarised as follows:—Whatever be the object pursued in artificial fertilisation, it is always very important to be well acquainted with the plants with which one works. It is not always enough to go back two or three generations. It is also necessary, and of the greatest importance, to select the plants intended to be used for the male with very great care; for I repeat again that the influence of the male greatly preponderates, as my repeated experiments have proved beyond doubt. It also requires perseverance, and minute attention must be given to the modifications which successively occur in the colour of the spathes of the Anthuriums, so uniformly fixed hitherto in the red and salmon colours of the type Rothschildianum.

A tendency towards other variations has indeed shown itself for some years past. I have thus been enabled to obtain by selection varieties with rose-cerise, rose-carmine, and coppery-salmon spathes. All these varieties are the result of crosses between Parisiense and a dark red variety, the former being the male plant, and the latter the female plant. I have had to operate twice, but I had not hoped to attain my object until after a third operation. It is obvious that the type of the Anthurium Scherzerianum being of a red colour, there will always be a tendency to revert to that colour. It has been comparatively easy to modify the foliage, which by judicious selection has been changed to such a degree that I have now plants having leaves of considerable width, and also short in proportion, which considerably enhances the general aspect of the plant.

An incident, which appears to me rather peculiar, occurred in my experiments about 1887, and deserves to be recorded. I obtained from a batch of seedlings of Anthurium Scherzerianum one plant, the aspect of which is absolutely different from the others: the leaves are perfectly erect, leathery, short, and very strongly petiolate at the base, with a sort of swelling which is very pronounced. The spathes are round, or nearly so, very thick, and, in fact, fleshy. The spadix is yellow and very strong. The general aspect of the plant resembles a Pothos. I named this variety Anthurium Scherzerianum Rex. Fertilised by itself, it is reproduced easily with very little variation; but all my attempts to obtain produce from it with other varieties have failed, or, at least, have only given me plants of no value. I may add that this variety is of slow growth, and always remains very compact. It is, moreover, so distinct that one could recognise it among a thousand others.

BROMELIADS OBTAINED BY HYBRIDISATION.

By Monsieur DUVAL.

THE nurseryman is glad to receive plants from the various regions where collectors go to hunt for them in order to send them to Europe.

It is with certain of these plants which he is able to cultivate and propagate that he enriches the horticultural world and satisfies the taste of the public, and at the same time he contributes, to a certain extent, towards the wealth of the country he lives in.

But his aim is frequently higher, for he is not always satisfied with the beauty or distinctness of the plants which he has received as new or rare; he is anxious to transform them, to improve them, and to give them more brilliant flowers, more perfectly shaped and of longer duration, together with a more generally pleasing appearance, and to render them hardier, &c. He consequently becomes a true creator, a transformer of the plant, for he acts according to his own judgment; he pursues a line of action which he has traced for himself beforehand, and he works often with confidence, sometimes with success, but always with forethought. And it is thus that he manages to obtain plants possessing such merits and so original in appearance that they have nothing in common with the types from their native countries; indeed, the collector himself would find it difficult to recognise them.

Edouard Morren, a very learned man, but at the same time a charming companion, and a great lover of plants, said one day in showing me his collection of Bromeliads:

"You ought to hybridise these plants. I assure you that there are some fine things among them, which if they were crossed would produce plants of considerable commercial value."

"I have myself," said Edouard Morren, "some crosses of which I am impatiently waiting the results, and I will show you shortly what can be done by artificial fertilisation, especially among the Vrieseas."

Alas! Edouard Morren died soon after this conversation, and I ascertained that the majority of his seedlings, the distinctive numbers of which were certainly somewhat mixed, were dispersed. In order to tell what they were, I was obliged to wait until they flowered, and then to sell under various names the Vrieseas, which so amply fulfilled the expectation of the late Edouard Morren—under the names of V. Leodinense, V. brachystachys major, V. Closoniana, V. intermedia, &c. Then appeared M. Truffaut's successes, Vriesea Mariæ, Alberti, and Versailliense; those of Kittel, those of Makoy and of Maréchal of the Liége Botanic Gardens, all these plants having various merits, some having a tendency towards a diversity of the forms of the bracts, and others possessing new colours, their principal merit being especially in their arrangement.

Struck with these results, and being already interested in what might be obtained by sowing Vrieseas crossed with each other, I obtained a

Vriesea known in the trade (1880) under the name of Vriesea splendens major of Duval.

When paying a visit to Mons. Kramer, gardener to Senator Jänisch, at Flottbeck, near Hamburg, I saw a very fine Vriesea with cherry-red bracts, but thin and subdivided, and which Mons. Kramer entrusted to me under the name of Vriesea Krameri.

But first I ought to say that at the same time as Truffaut obtained his Vriesea Mariæ I obtained Vriesea Morenno-Barilleti, which is, as its name indicates, the progeny of Vriesea Barilleti crossed by Vriesea Morenniana (a variety of Psittacina); and subsequently a Vriesea resulting from the fertilisation of Vriesea Duvali by Vriesea incurvata, which I named V. fulgida.

To return to Vriesea Krameri. It was, indeed, a storehouse of red for me; and acting in the same manner as a painter who would use all the carmine in a tube of that colour, I fertilised Vriesea Morenno-Barilleti with the Vriesea Krameri; and the results were as I anticipated, for I obtained Vriesea Rex, which has bracts of an intense red, and united in the form of a broad spatula, as in the Vriesea Morenno-Barilleti. Thus, in the first attempt, a green inflorescence, slightly marked with red, had been wholly coloured by the intervention of a plant the narrow bracts of which are entirely red. But, as it is always essential to improve and intensify the qualities of a plant, I at once thought that by fertilising the Vriesea Morenno-Barilleti by the Vriesea Rex I should not only obtain a plant stronger in every respect, but producing a much larger and finer inflorescence, and of a more decided and intense red. I named the result of this fertilisation 'Vriesea Rex major,' which gave me every satisfaction and confirmed my opinion that it is quite astonishing to see that each time one takes for the male, a plant having well-formed and very intensely coloured bracts, an accentuation in the colour of these bracts will invariably be obtained.

EXAMPLE.

Female.	*Male.*
Vriesea brachystachys, yellow and green bracts; plant small.	Vriesea Krameri, carmine red bracts; medium-sized plant.

Progeny.

Vriesea cardinalis.

Broad flat bracts, very intense red; medium-sized plant

Female.	*Male.*
Vriesea Barilleti, bracts yellowish green, dotted with brown; plant strong.	Vriesia Morenniana, bracts red in the middle, yellow on the edges; medium-sized plant.

Progeny.

Vriesea Morenno-Barilleti.

Bracts intense red at the base, the rest of the surface golden yellow; strong plant.

Female.	*Male.*
Vriesea Morenno-Barilleti (*see above*).	Vriesea cardinalis (*see above*).

Progeny.

Vriesea Rex.

Bracts having the same dimensions as those of V. Morenno-Barilleti, but entirely carmine red; strong plant.

Female.	*Male.*
Vriesea Morenno - Barilleti (*see above*).	Vriesea Rex (*see above*).

Progeny.

Vriesea Rex Major.

Bracts much larger than in Vriesea Rex, and of a much more intense red; strong plant.

If we take other species of Vriesea we find some very curious things to take note of. For instance the Brazilian species, such as V. brachystachys and its varieties, and also the ornamental species, such as V. fenestralis and V. tessellata, are excessively difficult to fertilise with pollen of species or varieties belonging to different countries. I have therefore had a great deal of trouble in obtaining four plants from Vriesea fenestralis (Parana) impregnated with the pollen of the Vriesea splendens major of Veitch (French Guiana). The result of this cross is quite extraordinary. It is the plant I named 'Vriesea Sphinx' (sown in 1889, it did not flower until 1898). It is three or four times the size of the mother plant (Vriesea fenestralis). The dark green foliage is slightly marked with transverse stripes. The inflorescence is about 2 to 2½ feet long, and is borne on a strong peduncle; the bracts are nearly the same shape as those of Vriesea splendens major, but what is calculated to puzzle the most competent grower is that they are of the purest green without the slightest indication of other colour. This result would seem to establish the fact that the colouring matter of the bracts of Vriesea splendens is not sufficient to influence the fertilising operations made with this species; but in spite of the difficulties I have experienced in employing Vriesea splendens and its varieties for the male I have persevered in using the pollen of this plant, and each time the result has been plants not possessing any trace of colour, or, at the most, only a very inferior colour. On the other hand, when I took Vriesea splendens and its varieties for the female I obtained some very fine things. Thus, for example, Vriesea Andreana = Vriesea splendens × Vriesea Morenno-Barilleti; Vriesea Elmireana = V. splendens × V. cardinalis; Vriesea Henrici = V. splendens × V. splendida. But a still more curious fact is that none of the progeny of Vriesea splendens bears any trace of its fine black stripes—not even the slightest indication of them. The general habit of Vriesea splendens certainly predominates; the form of the bracts and the inflorescence in shape like a sword are also maintained in the plants emanating from hybridisations performed on it, but that is all.

There are other species or varieties not less interesting to be studied

from the point of view of their artificial fertilisation. Of this number are the Encholirion (Vriesea) belonging to the types known under the name of Encholirion Saundersii, Younghi, coralinum, roseum, &c. These plants, which botanists have merged into the genus Vriesea, are, however, quite distinct, since we experience very great difficulty indeed when we try to transform them by fertilising them with Vriesias of the type brachystachys or its varieties. It has, nevertheless, been done by a skilful cultivator, M. Kittel, who fertilised Vriesea Barilleti with Vriesea (Encholirion) Saundersii, which gave him a plant named Vriesea Kitteliana, the appearance of which greatly resembles that of the male plant; but the bracts have been materially altered: they have inherited some colour and a more or less compact branching habit which is rather ornamental. Being desirous of further colouring these bracts, and so give them a more decorative appearance, I fertilised Vriesea Kitteliana by Vriesea Rex (Duval), and I at once attained my object by obtaining united bracts in the form of an erect spike, having five or seven ramifications of a very dark carmine red. The appearance of the plant is mixed, that is to say, between Vriesea Kitteliana and Vriesea Rex; but I must admit that the seedlings are not all so fine, and there are some which do not even equal the parents. The influence of Vriesea Barilleti (female) is possibly shown in a more marked degree, because it is already the grandfather of Vriesea Rex. One thing is certain, that by again fertilising Vriesea Kitteliana × Rex with Vriesea Rex we shall accentuate the red colour; but, on the other hand, we shall probably reduce the bifurcated form of the branches, as Vriesea Rex has a simple inflorescence, and not a subdivided one. But a much more curious point is that the majority of Vrieseas of the Rex type and their progeny show a tendency of giving to the second or third generation branched inflorescences, of which I am quite at a loss to give an explanation.

A very peculiar cross is that which I made with Vriesea Rodigasiana, a small species with drooping green foliage, but of firm substance. The inflorescence is composed of subdivided bracts in the form of a loose spike, and far from ornamental. Fertilised with Vriesea Rex and V. cardinalis, I obtained a variety to which I gave the name of Vriesea Vigeri, in honour of M. Viger, President of the National Horticultural Society of France. The result was quite extraordinary, as all the plants are strong, like Vriesea Rex, and give inflorescences composed of from eight to twelve subdivisions formed of bright red bracts, edged with yellow, and of a very ornamental effect. This fact, therefore, again strengthens my presumption that in the Vrieseas the male gives the colour, while the female seems to influence more the general habit. This is my idea, though it must not be regarded as an absolute rule; still, the notes which I have carefully taken seem to confirm my opinion.

If the Vrieseas cross rather easily with each other (notice I say, *rather* easily), the same is not the case with the Tillandsias: the peculiar shape of their reproductive organs, the manner in which they are inserted in the bottom of the often very deep calyx, and the quality of the pollen which only retains its fertilising properties for a few hours are sufficient obstacles to the artificial fertilisation of the Tillandsias. I do not think there are many instances of hybridisation effected with these plants;

for, as far as I am personally concerned, I have attempted the operation for more than three years without success, between Tillandsia Lindeni major (Hort.) and Tillandsia Lindeni vera (William Bull). Whatever botanists, and particularly the great explorer M. Ed. André, may say, these two plants appear to me very distinct, if not by their reproductive organs, at least by the conformation of their inflorescence and their outward form, which is so very different that it is practically impossible to mistake them for each other. After more than sixty unsuccessful experiments in fertilisation, I was at last fortunate enough to obtain two pods of seeds, which, sown in good condition, produced thirty or forty seedlings, the greater part of which died the first year. Out of the ten plants which remained I had the pleasure of seeing one of them, after six years from the time of sowing, give its inflorescence, which is exactly intermediate between the two parents, as indeed the whole plant is. For example, the spathe of Tillandsia Lindeni major raises itself erect above the foliage, supported by a long flexible stem: its appearance is that of a spatula, slightly bent and hollowed like a spoon, coloured only on one side with pale pink. The flowers are blue and of medium size.

Tillandsia Lindeni vera is not nearly so strong a plant as Tillandsia Lindeni major (William Bull). It has an inflorescence shaped like a spatula, but larger than that of Tillandsia Lindeni major. It is supported by a rather short peduncle, and shows a tendency, to droop as though bent down by its own weight. Its colour is rather bright pink, but on one side the flowers are blue, large, and of short duration. My seedling, which I named Tillandsia Duvali, is exactly intermediate between the two parents: the foliage partakes of the nature of both T. Lindeni major and T. Lindeni vera. The erect and solid spike stands well above the foliage on a stalk about 6 inches in length. It is as strong as that of Tillandsia Lindeni vera, and has a peculiar characteristic in being coloured on *both* sides with bright pink. I believe it is the first time a hybrid obtained from the Tillandsias has been seen which has been sown and cultivated in Europe. All my attempts to fertilise the Tillandsias of the type Lindeni, Regeliana, &c., with Vrieseas, and *vice versa*, have failed. For the present it would, therefore, appear to be advisable to make two distinct sections:—1st, Vrieseas, properly so called; and 2nd, Tillandsias.

Another class of Bromeliads which are very difficult to cross with each other are the Caraguatas, especially Caraguata cardinalis. Whatever may be the opinion of botanists, I absolutely refuse to regard Caraguata cardinalis as a mere variety of C. lingulata splendens. These two plants appear to me quite different, not only as regards outward appearance, but by the extreme facility with which Caraguata lingulata splendens fertilises itself without any artificial means; whilst on the other hand it has hitherto been impossible to obtain seeds on Caraguata cardinalis. I have myself attempted the operation without any success; and if I have at last succeeded in getting two capsules of seeds on a Caraguata cardinalis, it is by fertilising it with the pollen of a Caraguata lingulata splendens. It is, moreover, the same with Bilbergia Rhodocyana, a very fine species, and greatly valued from a horticultural point of view: its fertilisation is exceedingly difficult—in fact almost

impossible—and it requires a great deal of patience and attention so as to avail oneself of the opportune moment to convey to the female organ the pollen, which is scarcely ever in a state to effect the fertilisation. It is very desirable to fully determine the nature of Bromeliads and their relation to one another; for in hybridising and sowing the nurseryman certainly finishes by acquiring considerable skill, and he therefore acts with a sort of special gift which leads him to suppose that such or such a species can be fertilised by another. But often a great deal of time is wasted in vain attempts, owing to scientists not agreeing on the correct genus of the plants.

The following example will serve to show what I mean. There is a very fine plant called Vriesea magnifica. It is supposed that this plant is the result of a cross between Caraguata Zahnii and Vriesea splendens. It is, indeed, at first sight quite intermediate between the two parents; but Caraguatas, are they or are they not Caraguatas? Or if they are, how can their being fertilised with the Vrieseas of the Splendens type be explained, seeing that the Vriesea splendens themselves are difficult to cross with other Vrieseas? I leave it to others to explain these things, for up to the present, in spite of my efforts and numerous trials, I have been unable to obtain anything between Caraguata Zahnii and Caraguata lingulata, nor with Caraguata cardinalis; and yet they are true Caraguatas.

I could quote other curious cases of fertilisation, introducing surprises of a nature to puzzle or delight the sower. An excellent cross was effected by a nurseryman of Versailles—M. Lemaître—on Vriesea hieroglyphica with our Vriesea cardinalis, which confirmed my views in every respect, as the result—Vriesea mirabilis—is a plant having a large spike, bifurcated into several parts and highly coloured with red. There, again, the female plant acted as regards the general form and habit and the male as regards colour. The pretty markings of Vriesea hieroglyphica disappeared altogether in Vriesea mirabilis. The foliage of Vriesea cardinalis being of a very light green, is that not another proof of the influence of the male plant in the colouration?

In order not to unnecessarily lengthen this paper I may sum up by saying that the field concerning Bromeliaceous plants is a very extensive one, and I could quote examples without number in support of the points I have advanced in connection with the influence of the male parent. I have drawn up a table which will assist in proving this point, and will also show the part I have contributed towards obtaining ornamental Bromeliads. Trade has its requirements, and the nurseryman, if he would not be left behind, must continually be on the look-out for plants possessing capacity for the extension of both the range of colour and also of ornamental effect, things which imported plants do not always possess. His endeavour should be to improve them to such an extent, both in brilliancy of colour and in beauty of foliage, that at last he succeeds in producing absolutely faultless plants. What is the determined object which every true cultivator pursues? To create plants more beautiful than even Nature herself has produced? Certainly not—for Nature is the greatest of artists, and man can only assist her admirable work. Nevertheless, it is given us to satisfy the demands of trade by

supplying to our gardens a far greater diversity of colour and form by crossing natural plants, and to respond to the suggestions of æsthetic tastes by developing the hidden forces of plants in this direction or in that. And who amongst us does not desire that the plant or the flower which he has produced with great labour and skill should not be thought beautiful by all the most refined of mankind, and that those who can afford it should be willing to lavish their money upon it? And all these desirable things may be the glorious result of scientific hybridisation.

When I devoted myself to such an interesting family as Bromeliaceæ, of which the Vrieseas are those which lend themselves best to modification, it was because I knew that I should be able to eventually obtain improvements which would enrich the horticultural world with a series of varieties of Vrieseas—to only quote one genus—capable of giving universal satisfaction, and of which I am very proud of having been one of the most enthusiastic promoters.

HYBRID BROMELIADS OBTAINED BY MONSIEUR L. DUVAL.

Species	Hybrid	Seed Parent	Pollen Parent	Date
Vriesea	Andreana, H.D.	Morenno-Barilleti	+ Splendens Major	1894
,,	Aurora Rex H.P.	Aurora	+ Rex	1898
,,	Bijou, H.D.	Morenno Barilleti	+ Tulgida	1893
,,	Cappei, H.D.	Van Geerti	+ Cardinalis	1894
,,	Cardinalis, H.D.	Brachystachis	+ Krameri	1890
,,	Cardinalis superba	Cardinalis	+ Morenno Barilleti	1894
,,	Conferto Rex	Conferta	+ Rex	1899
,,	Devansayana	Brachystachis	+ Krameri	1893
,,	Duchartrei	Morenno Barilleti	+ Splendida	1894
,,	Ducreti	Morenniana	+ Van Geerti	1895
,,	Dufricheana	Duvali	+ Psittacina	1890
,,	Duvaliana Major	Duvali	+ Tulgida	1894
,,	Elegans	Morenno Barilleti	+ Duvali	1894
,,	Tenestralo Tulgida	Tenestralis	+ Tulgida	1894
,,	Tulgida	Incurvata	+ Duvali	1899
,,	Gemma	Morenno Barilleti	+ Tulgida	1893
,	Griesseniana	Encholision Coralinum	+ Rex	1898
,,	Gloriosa	Barilleti	+ Incurvata	1894
,,	Elmireana	Splendens	+ Cardinalis	1895
,,	Henricii	Splendens	+ Splendida	1894
,,	Imperator	Magnisiana	+ Rex	1899
,,	Kitteliano Rex	Kitteliana	+ Rex	1899
,,	Kramero Tulgida	Tulgida	+ Krameri	1893
,,	Minima	Morenniana	+ Duvali	1893
,,	Morenno Barilleti	Barilleti	+ Morenniana	1889
,,	Nanoti	Morenniana	+ Tulgida	1894
,,	Poelmani	Gloriosa	+ Van Geerti	1897
,,	Poelmani superba	Gloriosa	+ Van Geerti	1897
,,	Psittacino Tulgida	Psittacina	+ Tulgida	1893
,,	Psittacino splendens	Psittacina	+ Splendens	1894
,,	Rex	Morenno Barilleti	+ Cardinalis	1893
,,	Rex Superba	Morenno Barilleti	+ Rex	1897
,,	Rex nigrescens	Morenno Barilleti	+ Rex	1899
,,	Speranza	Kitteliana	+ Van Geerti	1898
,,	Sphinx	Tenestralis	+ Splendens	1893
,,	Splendida	Duvali	+ Incurvata	1889
,,	Witteana	Morenno Barilleti	+ Splendens	1894
,,	Vigeri Minor	Rodigasiana	+ Cardinalis	1898
,,	Vigeri Major	Rodigasiana	+ Rex	1898
,,	Vassillieri	Tenestralo Tulgida	+ Van Geerti	1899
,,	Witteano Rex	Witteana	+ Rex	1899
Tillandsia	Duvali	Tillandsia Lindeni Major	+ Tª Lⁿⁱ Vera Sª	1899

(This list of 42 plants, which are all the result of my own hybridisation, is not final, as I have more than thirty sets of plants still to flower.)

GLOXINIAS AND THEIR ARTIFICIAL FERTILISATION.

By Monsieur DUVAL.

GLOXINIAS are certainly very easy to fertilise, and a horticulturist unaccustomed to stove plants will not fail to perceive that they have very simple reproductive organs which offer themselves readily to fertilisation.

Does it then follow that it is easy to obtain all the varieties one would like? or that one can successfully fertilise and cross with each other the different varieties (the word species appearing rather strong) which are now in cultivation?

That is another matter; and I think it advisable to deal with this subject here, so as to fix certain points which may require to be elucidated, or which have been badly understood and consequently misinterpreted.

About the year 1860, when the first Gloxinias (*Ligeria*) with erect flowers made their appearance, there were few varieties. I only saw two varieties, or three at the most, in flower at the establishment of François Duval, my father--one pink variety, one pale blue, and one white with blue dots at the intersection of the segments. These Gloxinias were at that time rather poor in appearance, and their flowers were comparatively small. They were named 'Fiffiana,' derived from the name of Fiffe, I believe.

Where did they come from? Doubtless from England. By what channel? Through Thibaut and Keteleer or Rougier. It is, however, of little consequence. At all events, I saw them sown, thrive, and give in succession large flowers with more and more defined colours, and at the same time holding themselves up better. In spite of the appearance of the Gloxinias of Fiffe, Gloxinias with drooping flowers were still grown. Van Houtte obtained some very fine plants, but with drooping flowers. He sent out a variety, which he dedicated to Madame Van Houtte, under the name of *Gloxinia Mina*. At that period—that is to say, about 1866—we possessed both drooping and erect flowered varieties, but nearly all of one colour and without any brilliancy.

The appearance of the *Gloxinia Mina*, the colour of which was very brilliant carmine-red edged with white, caused me some surprise, and gave me the idea that by means of this rich-coloured plant superior varieties might be obtained. Indeed, by fertilising the varieties I possessed, and which were erect-flowered, with the drooping-flowered variety Mina, I obtained plants with erect flowers of a brilliant red colour edged with white. The flowers of a hitherto drooping type were therefore made erect as the result of the first attempt.

This was the commencement of a new race, and to obtain several colours was the object in view and which I endeavoured to accomplish. By fertilising the progeny of *Gloxinia Mina* with other varieties, I had the pleasure of seeing a whole series of plants blossom of various colours—dark and light blue, pink, red, &c.—and all with erect flowers.

But meanwhile my colleague J. Vallerand, sen., had crossed the Sinningia-Gloxinia, of a lilac-white colour, dotted all over with dark violet, with *Gloxinia erecta*. As the result of this hybridisation, he obtained some very curious and new things: plants with very finely spotted and marked flowers. It was a veritable revolution! During this time I acquired from M. Eugène Vallerand a series of Gloxinias (*Ligeria*), in connection with which it will be necessary to say something These Gloxinias were of a very special type, and I believe were obtained from an able cultivator named Rossiaud. Very distinct in habit, these plants had rounded thick leaves, which, as well as the stems, were of a velvety nature; the buds were plump, short, and strongly petiolate; the flowers were large, of fine substance and very wide open; but they had a very narrow tube, and the colours, which were not very diverse, ranged from dark blue to cherry red, passing through bright rose or a white ground marked with blue dots.

They were, in short, very distinct Gloxinias, having nothing in common with those we possessed before; nor with those of the elder Vallerand which had been crossed with *Sinningia*. They were afterwards given the name of 'Crassifolia.' Where did these types come from, and what was their origin? For they bear so little resemblance to the male parent from Brazil, that it was easy to discriminate them at first sight. To fix this type, improve it, give it the colours wanting, and above all render it floriferous and less stiff—that was my task. I devoted ten years to it, from 1869 to 1879/1880, and during that period I have been enabled to obtain not only a great diversity in colour, but also pure whites, and moreover exceedingly floriferous plants. Under the influence of cultivation and continual selection I saw the type transformed, produce numerous buds, compact and abundant flowers, and assume a totally different aspect.

The origin of these *Gloxinia crassifolia* is indeed a mystery. Is it a type come spontaneously, and which has thus produced itself alone? I do not think so, for the first *Gloxinia* (*Ligeria*) *crassifolia* had drooping flowers, and their general appearance resembled that of the *Gloxinia pyramidalis*. Did the intervention of the latter take place at the opportune moment, and with what variety? Or was it Rossiaud who, wishing to fertilise the *Gloxinia pyramidalis*, did so with the Gloxinia (*Ligeria*) obtained direct from Brazil or already improved on by him? At any rate, one thing is certain, and that is that the *Gloxinia crassifolia*, although improved, have never allowed themselves to be fertilised by the Sinningias or their descendants. I have tried this operation several hundreds of times, but without success, and I leave it to others to tell us when they have proved successful.

The type *crassifolia* has at no time had dotted flowers; it is fixed and unchangeable; the colours have been improved, and, as I have already remarked, I have been able by dint of patience and time to transform it in such a manner that it is now quite as free-flowering and as rich in colours as the type called 'Vallerand's Type.' How has this transformation been effected? It is the result of repeated fertilisations, it is true; but one must also take into account the improvements which were produced as I proceeded with the fertilisations.

Thus, in connection with the colour, I have said that the *Gloxinia crassifolia* had only three very inferior colours at the commencement, viz. dark vinous red, dark blue slightly silvered on the edges, very pale violet and rose. It was necessary to select from these colours the best. and it was by continual sowings that one day I obtained much purer colours, viz. pure carmine, pure violet with a slight white border. Then, on experimenting again, I obtained the whole series of selfs edged with white, which were destined to become such favourites under the names of 'Le Progrès,' carmine-red edged with white; and 'Patrie,' dark blue edged with white. I obtained at the same time a plant of a magenta-lake colour, which, fertilised by a red variety, produced an amaranth-coloured flower, which also had a white margin. I at last obtained the pure white *Gloxinia crassifolia*, together with the whole series of ground colours; so that in a few years I created from a stiff, rigid plant, impossible to pack, with very inferior flowers, a type having an abundance of rich-coloured flowers, and perfect both as regards habit and inflorescence. In such a matter the greatest attention must be paid to the choice of the seed-bearing plants.

With regard to the colours, it is very important to observe that the hybridiser must proceed exactly as the water-colour painter does; for instance, if he is desirous of obtaining fine distinct colours, he must only use, for the male parent, plants having pure, well-defined colours. Consequently, a carmine-red plant should be considered as a cake of paint of that colour; and if a dark blue variety is fertilised with that plant, four-fifths of the plants will be of a fine purplish-violet colour. If one takes a rose variety for the female and a dark carmine for the male, an intermediate colour of a bright pink will be the result. If, on the contrary, a plant of a mauve or magenta colour is fertilised with a bright carmine, one will obtain the amaranth colour known under the name of "magenta."

The mingling of colours, or their intensifying or lessening, is thus a matter of absolute certainty. It is like a palette at the disposal of a painter. It is, however, necessary to be well acquainted with the genealogy of the plants, to have studied them for a long time, for without, one will only get unexpected and curious reversions.

A red plant may have been fixed as the result of selection, but if it have blue or magenta in its blood (horticulturally speaking) it would not be surprising if, having this origin, its progeny should come out half red, half magenta—or worse.

Some types have been fixed in such a way that it becomes practically impossible to alter them. I have obtained a Gloxinia named 'Boule de Feu,' the very brilliant carmine-red of which has defied the intermixture of every other colour.

This plant, which had for its great-grandfather the Gloxinia 'Mina' of Van Houtte, has served us as a mine of colours for some years, the richness of its tints being inexhaustible. Everything I fertilised with this plant assumed superb colours, blues, pinks, magenta, violets; all these plants, impregnated by the Gloxinia 'Boule de Feu,' produced remarkable colours and of incomparable brilliancy.

But when I desired to fertilise my 'Boule de Feu' by other

coloured varieties, two-thirds of the produce were 'Boule de Feu,' and the remainder of very little value.

I have come to feel such a certainty in my hybridisations that I can work like a painter in water-colours, by placing one colour over another, and not by mixing the tints; that is to say, to take a Gloxinia with deep violet-blue flowers, perfectly fixed as regards colour, and fertilise it by an equally well-fixed red one, and then not have any mixture of colours at all, but a superposition, a glazing of red over violet of very fine effect. In order to operate in this manner, one must be very sure about his plants.

I think the preceding notes will suffice to thoroughly show the advantage to be gained by acting in fertilisation with plants of which the origin has been properly studied and the sources of parentage have been carefully preserved.

Such methods are absolutely indispensable to all who are desirous of making fertilisations, and secure results which are not entirely due to chance.

My friends, MM. Vallerand, have been able to carry to the utmost perfection the race of dotted and marked Gloxinias and the sub-varieties; I have brought, by dint of work and attention, the race of Crassifolia to a perfection which, I am entitled to think, has not been excelled.

What I have written may still help those who wish to attempt to improve it further!

NOTES ON HYBRIDS.

By THOMAS MEEHAN, Germantown, Philadelphia, U.S.A.

MY actual experience in hybridisation is interesting though not extensive. It began in my fourteenth year, and with the Fuchsia. My father was an excellent botanist, and a great lover of rare plants. The plant-house at St. Clare was not large, but friends frequently sent him cuttings of rare things and flowers of new introduction. *Fuchsia fulgens* had been introduced a year or so before, and someone sent my father a few flowers. I was the "garden boy" under my father. Fond of garden experiments, I had decided to repeat Knight's work in hybridising garden Peas, when the large amount of pollen on the Fuchsia flowers interested me. It was applied to the stigma of *Fuchsia longiflora.* From the one berry that resulted several dozen plants were raised. The largest and best of these subsequently appeared in the trade through the agency of Youell & Co., of Yarmouth, as 'St. Clare.' An interesting lesson followed. From this one berry no two of the many seedlings were alike. Some nearly approached the female, some the male; none could fairly be said to be intermediate. It was evident that the action of the pollen had not alone to do with the variation. Some physiological fcrce, to this day not understood by me, must have been co-ordinate in the production of these results.

Subsequent to this I made an experiment with the *Diplacus puniceus* and *D. glutinosus.* These seedlings were all exactly intermediate in the colour of the flowers, a bright orange; but there were no other differences. From the orange colour I named them *D. aurantiacus.* Others must have experimented, and with the same result, for I do not think the one figured in the "Botanical Register" came from my stock.

My next experiment was some years later in America. *Disemma aurantia,* the female parent, and *Passiflora cœrulea,* the male. To my surprise the progeny was simply the *Disemma.* There was no trace of the Passionflower in them. To an objection that might be made I will note that an intelligent hybridiser knows how to avoid the action of the plant's own pollen in experiments of this kind.

Some few years later I endeavoured to produce a new race of Fuchsias from *F. arborescens* pollenised by garden hybrids. The seedlings both in foliage and flowers were *F. arborescens* and nothing more. To the objection that the pollen of a hybrid may have been impotent I may reply that these hybrids produce berries frequently with no pure species near them; and though I have not sown the seeds, I have heard of others raising plants from them. Moreover due precaution was taken to avoid the action of their own pollen.

In recent years I crossed a flower of *Rosa Kamtschatica* with pollen of 'General Jacqueminot.' Only two plants grew from the seeds in this one pod. One of these plants was exactly *Rosa cinnamonea*; the other had all the appearance of the 'General,' but was attacked so persistently

by a parasitic fungus that, in spite of all effort, it died at the end of its second year, and before flowering.

These have been my most instructive experiments. What has been done with Geraniums and other florists' flowers has still been instructive in this, that hybrids are just as fertile, and the pollen just as potent, as in the original species. Barrenness occurs as often among individuals of pure species as among the progeny of individuals resulting from hybridisation. Sterility results from some physiological law, of which pollenisation is but an incident.

In regard to the supposed sterility of hybrids, Dr. Engelmann describes in his well-known paper on American Oaks a number of supposed hybrids in nature. In one case, *Quercus palustris* × *imbricaria*, he cites its sterility in evidence. Before the tree was destroyed by a railroad track he found a solitary acorn. This grew and is now a large tree on my grounds, and is of exceptional fertility, producing a large crop of acorns of pure *Quercus palustris*, and with the foliage and habit of the same species, though there are numerous leaves entire, as in *imbricaria*, but in venation and all other characters it is wholly *Quercus palustris*.

Though hybrids in nature are probable, we have little direct evidence of the fact. The occurrence of intermediate forms, or of sterility in some cases, is no evidence, especially when we know of the wide range of variation in such cases, for instance, as in monotypic species, where cross-pollenation is out of the question.

CHRYSANTHEMUMS.

By Mr. H. Weeks, F.R.H.S.

My first attempt at cross-breeding the Chrysanthemum was made some eleven or twelve years ago upon plants grown upon what is generally known as the "big bloom" system. For several years I was unsuccessful, until 1892. Failing to grow that beautiful variety 'Mrs. Alpheus Hardy' in the orthodox way, owing to its weak habit, I decided to try striking the cuttings in summer, and growing the plants in small pots. From these plants I obtained some fine blooms, and I was so much struck with the beauty of this variety that I made up my mind to again make an attempt to obtain seeds, although I had almost given up the idea. However, from this effort I obtained four seeds. I have no doubt I should have obtained more, but for the fact that the blooms were too far advanced for fertilisation when I commenced operations. My success, though small, suggested to my mind that my previous failures were due to selecting plants for the purpose which had been too highly cultivated, so the following year, from the middle to the end of July, cuttings were taken from plants which had been planted in a piece of poor ground early in the year, and inserted thickly round the side of small pots and placed in a cold frame. As soon as well rooted, they were potted singly into 3½ in. pots, using poor but open soil, my object being to have the plants in a semi-starved condition by the time of flowering. The plants were returned to the frame until established, when they were removed outside until there was no danger of frost. They were then placed in a dry, airy house having a day temperature of from 50° to 55° without sun heat. As soon as the florets were sufficiently expanded they were cut back with a pair of scissors until the stigma was exposed. When in a condition to receive it, the pollen was applied each day about noon. From this batch I obtained about 200 seeds; but having neglected to observe in previous years that not all varieties produced pollen I had few pollen-bearing plants, and these the least desirable varieties. That year I observed that crimson and yellow produced pollen more freely than any other colour, white being the least productive. Seedlings, with very few exceptions, produce an abundance the first year; but after that no particular variety can be depended upon until it has been proved to be a pollen bearer.

Whether soil or cultivation has any bearing upon the production of pollen I am not in a position to say, but I have noticed in other collections varieties bearing pollen which have failed to do so with me, so that my experience may not be general. 'Vivian Morel' is a variety I might mention as an example. This I saw in a collection six years ago bearing pollen, but although I have grown it ever since I have up to the present failed to obtain any from it. In addition to this I find this type (that is, the true Japanese type) most difficult to hybridise, the incurved Japanese being much freer in both respects.

I should also have made an exception of the true incurved type in the matter of pollen bearing, as I cannot call to mind a variety which I have

not seen bearing pollen; and, besides this, they are more easy to fertilise than any other type. There are some varieties among the Japanese which produce bracts or green scales (if either term is botanically correct) between the florets, something after the style of a double Zinnia. These are among the easiest to fertilise. I cannot account for this unless their presence gives the ovary more room to develop, as these scales appear to take the place of florets. Consequently the seed vessels are not so tightly packed together as in other varieties.

Being anxious to test whether my theory that the non-fertility of the flowers of large plants was due to too high cultivation, a few years ago I selected several large plants, treating them the same as the smaller ones; those intended for the female, or seed bearing, did not mature a seed, while almost all the centre florets of the pollen bearers matured seeds. These were sown in due time, but all came single or semi-double, and although all must have been fertilised with their own pollen (as I used separate brushes), not one resembled its parent. I also found on examining the outer florets of the flower intended for the female parent that, although the stigma looked very tempting to an hybridist, the ovary had taken the form of a small deformed floret; in fact some of them, though small, had thrust themselves up the tube of the floret. From this I formed the idea that the outer florets would produce the most double flowers, and from results obtained I found that the extreme outer row produced from 80 to 90 per cent. of double flowers, while the nearer the florets fertilised are to the centre, the greater the percentage of single flowers. I now remove all but the outer row of florets before commencing operations, except in the case of incurved Japanese and true incurveds, when several rows are left, as it is not desirable to have the centre too full in this type.

I have also tried various times of the year for propagating for this purpose, but have found none more suitable than that previously stated, for if started too early the buds which form first have a tendency to doubling in the outer florets the same as in the large plants. This would be a greater drawback still in the pollen-bearing plants, as an open centre is essential, and blooms from this bud in most cases would be too full in the centre, while if the plants are grown on to the next bud the plants would require a larger pot: the plants would not be such a convenient size, and the raiser gain no better (if as good) results.

In conclusion, with my short experience in hybridising the Chrysanthemum, it would be assumption on my part to pose as an authority on the subject, as there are many who have had a longer experience than I who may differ with me in some points. Therefore, although this paper is based on observations made during my short experience, I may yet have reason to alter my convictions in some respects, as I believe there is yet a great deal to be learnt on this particular subject.

ON THE CROSS-FERTILISATION OF THE FUCHSIA.

By Mr. JAMES LYE.

ALL the varieties of Fuchsias I have raised during the past thirty-four years have been from definite crosses, made with a view to improvement in habit of growth, freedom of bloom, and size and symmetry in the individual flowers. What I have kept steadily in view has been the production of a variety with a pure white tube and sepals, in combination with a deep plum-purple corolla.

I have been most successful in obtaining fine varieties when the act of cross-fertilisation was performed in the month of September. I generally make light-coloured varieties the seed-bearing parents, as they are more prolific seed-bearers, especially such varieties as 'Arabella,' 'Arabella Improved,' 'Lye's Favourite,' 'Louisa Balfour,' &c., and use the pollen of dark varieties.

The plants to be operated upon for fertilisation are placed under cover, and all the openings through which air is admitted are covered with a fine netting or sheets of perforated metal, to prevent bees and other insects from entering the house and interfering with the work of impregnation.

The pollen is mature within four or five days after the flower is fairly expanded, if the weather be favourable. The best time of the day to cross-fertilise is about noon, when the flowers and pollen are both dry.

I make use of a camel's-hair brush to convey the pollen to the seed-bearing parent, and the two plants employed for the purpose are brought close together, so that none of the pollen be lost in the act of transmission.

When I desire to obtain a quantity of seed, I fertilise the flowers, using the point of a squirrel's tail to convey the pollen from one to the other. Nothing of the character of a hard substance should be employed in the process, in case injury be done to the delicate stigmas of the flowers.

When I have been unable to devote a house wholly to purposes of cross-fertilisation, and have had to keep the plants with others where there are open ventilators, the particular blossoms operated upon have been enclosed in light muslin bags, as they are preferable to those made of thin paper. If the sepals are extra long, they are often removed when the flower is covered.

When the seed pods are sufficiently ripe for gathering, they are carefully opened by means of a sharp penknife; the seed grains extracted and laid upon a piece of paper to dry, when they are placed in a box or some receptacle which is perfectly air-tight, and then sown in early spring in a temperature of from 60° to 70°.

The first cross I attempted was by taking the pollen from a dark variety named 'James Lye,' fertilising with it the light variety 'Arabella.' From this I got encouraging results, 'Arabella Improved' being among the progeny. I then crossed 'Arabella Improved' with 'James Lye,' which

produced several very fine varieties, such as 'Charming,' one of the most useful and popular decorative and exhibition varieties; 'Elegance' and 'Bountiful,' dark; 'Star of Wilts,' 'Beauty of Wilts,' 'Lye's Favourite,' 'Letty Lye' (which makes an excellent bedder), and other light varieties.

I have also used as a seed parent 'Louisa Balfour'—a light seedling of my own—and 'Mrs. Rundle' also, crossing them with 'Charming' and 'Wiltshire Giant,' securing fine and distinct varieties; and also in the case of 'Jubilee,' a fine light, crossed with the dark 'Masterpiece'; and an exceedingly free light variety named 'Amy Lye' with 'Clipper,' also a dark variety. 'Masterpiece' and 'Clipper' are two valuable free-blooming varieties for conservatory decoration, of vigorous growth, and lasting a long time in bloom.

I have never made use of double-corolla'd varieties for fertilising purposes, and from all my crosses have had but two or three semi-doubles: one, 'Wiltshire Giant,' I thought good enough to name; and also 'Snowdrop,' the only seedling I have raised with a white corolla: it produces long globular buds, and, when expanded, a white petticoat-shape corolla.

NOTES.

By Mr. W. Smythe, F.R.H.S.

In crossing Begonia weltoniensis with a scarlet seedling of the ordinary tuberous type I did so with the idea of producing a bedding variety of the weltoniensis breed, but with the hardiness of the male parent, and capable of standing the whole summer, regardless of inclement weather. The result was the Begonia I have called 'Basing Park Hybrid,' which produces stout, bushy plants of quite a good bedding habit and a profusion of flowers, but with the tubers quite distinct from the male parent. It stands well in beds from early summer until the autumn frost, and bears its flowers up well against rain or any stormy weather.

Phaseolus multiflorus × Phaseolus vulgaris.

For many years I have fertilised the Dwarf Bean with pollen from the Scarlet Runner, and have then crossed and recrossed the best selected hybrids therefrom. I have succeeded in getting many different varieties. The first break resulted in plants of the Runner type, about 3 feet in height, which only produced ill-formed pods, and were much too late to be of any real use, except, perhaps, in dry warm countries. They produced scarlet flowers on racemes in the same way as the old Scarlet Runner. But with another recross from the best of the former hybrids I obtained three good dwarf varieties about 2 feet high, with every characteristic of the Runner in regard to the thick fleshy pods, and flowers borne in long racemes. The pods are of a fine flavour. The seeds are small, like the Dwarf.

In fertilising Beans great care must be taken to remove the stamens in order to avoid self-fertilisation. Carefully remove or cut the petals before introducing the foreign pollen. I find a camel-hair brush best for the purpose, so as not to injure the stigma.

I find the greatest trouble is to get the hybrid Bean to assume a fixed character. Individual plants differ so much in the colour of their flowers and seeds, although the pods are exactly alike. This Bean is remarkably productive, and of a perpetual-bearing character.

Tacsonia Smytheana ×.

This was the result of crossing T. mollissima ♀ with T. manicata ♂. My object was the production of a flower of a brighter colour (or even scarlet), which was so much wanted among the Tacsonias. Nor was I disappointed, for the hybrid has apparently taken its brightness of colour from its pollen parent, but is quite distinct from either in regard to the length of the tube and the habit of producing its flowers. They are produced in a horizontal manner from the growth, which is unlike any other of the Tacsonias. The foliage resembles T. manicata, but the petals of the flowers are inclined to incurve, which is distinct from either parent.

NOTICES TO FELLOWS.

APRIL 1, 1900.

FRUIT.

Figs, Peaches, and Nectarines will be ready from about the second week in June and onwards. Fellows can purchase the same by writing to *The Superintendent, R.H.S. Gardens, Chiswick, W.* Prices will vary according to the size of the Fruits. If sent by post the carriage will be charged extra.

LETTERS.

All letters on *all* subjects (except the above) should be addressed—The Secretary, R.H.S., 117 Victoria Street, Westminster.

TELEGRAMS.

"**HORTENSIA, LONDON,**" is sufficient address.

PLANTS.

A List of Plants to choose from was sent to every Fellow on January 30 (as it is every year), and the ballot for order of distribution was made on March 1. All Fellows participate in the yearly distribution in the March **following** their election. No distribution can be made later in the year, though from the large number of Fellows to be served it is often the end of April before the March distribution is completed.

DRACÆNAS.

The Superintendent, R.H.S. Gardens, Chiswick, would be greatly obliged for any old plants of Dracænas, however old and long. Please shake all the earth out and send them direct.

SUBSCRIPTIONS.

All Subscriptions fall due on January 1 of each year. To avoid the inconvenience of remembering this, Fellows can *compound* by the payment of one lump sum in lieu of all further annual payments; or they can, by application to the Society, obtain a form of instruction to their bankers to pay for them every January 1. Fellows whose subscriptions remain unpaid are debarred from all the privileges of the Society; but their subscriptions are nevertheless recoverable at law, the Society being incorporated by Royal Charter.

MEETINGS AND SHOWS.

1900 (remaining)—April 24; May 8; 23, 24, 25 *Temple*; June 5, 19; 27 *at Richmond*; Rose Show July 3; July 17, 31; August 14, 28; September 11, 25; 27, 28, 29 Fruit Show at *Crystal Palace*; October 9, 23; November 6, 20; December 4, 18.

NOTICE OF MEETINGS AND SHOWS.

A reminder of every show will be sent, in the week preceding, to any Fellow who sends to the R.H.S. Office, 117 Victoria Street, S.W., 24 half-penny post cards, *ready addressed* to himself.

TEMPLE SHOW.

May 23, 24, 25. Fellows of the Society are admitted free on showing their tickets. *N.B.*—Each *personal pass* is strictly non-transferable, and will admit the Fellow to whom it belongs, but no one else. The Public are admitted by purchased tickets; on Wednesday, May 23, from 12.30 to 5 P.M., 7*s.* 6*d.*, from 5 P.M. to 7 P.M., 5*s.* On Thursday, May 24, from 10 A.M. to 7 P.M., 2*s.* 6*d.* On Friday, May 25, from 10 A.M. to 6 P.M., 1*s.*

To avoid the inconvenience of crowding, tickets may be obtained on or before May 21 at the Society's Office, 117 Victoria Street, S.W., or at the Treasurer's Office, Inner Temple.

The Society Office at Westminster will be closed on the days of the show, and consequently no letters should be addressed there on the previous day.

On the days of the show tickets will only be on sale near the entrance to the Gardens on the Thames Embankment.

Members of Affiliated Societies and *bona fide* Gardeners may obtain 2*s.* 6*d.* tickets for 1*s.*, which will admit them on Thursday, May 24. These tickets *can only be obtained* on or before May 21 *from the Society's Office*, 117 Victoria Street, S.W., and a large stamped and directed envelope must be sent with Postal Order in every case. Members of Affiliated Societies MUST apply *only through the Secretary of their own Society*, if they wish to take advantage of this privilege.

SPECIAL MEETING

at Richmond, June 27. See book of "Arrangements, 1900," p. 67.

SPECIAL ROSE SHOW,

July 3, at the Drill Hall. For Schedule of Prizes see book of "Arrangements, 1900," p. 68.

GREAT SHOW OF BRITISH-GROWN FRUIT.

Sept. 27, 28, 29. Fellows are particularly requested to subscribe a small sum towards the Prizes, as £100 must be raised immediately. Send to the Secretary. Schedules of the Prizes can now be obtained.

LECTURES, &c.

Any Fellows willing to Lecture or to communicate Papers on interesting subjects are requested to write to the Secretary.

BINDING THE JOURNAL.

The present issue forms a complete Volume by itself—Vol. XXIV. The Title-page and Table of Contents will be found enclosed, and should be placed at the beginning, and the Index at the end. *N.B.*—The concluding Part of Vol. XXIII. will be issued in a few weeks.

NEW FELLOWS.

The Secretary makes a **Special Appeal** to all Fellows to assist in promoting the welfare of the Society by doing all in their power to INTRODUCE NEW FELLOWS. The Society would particularly welcome the adhesion of Foreign Gentlemen interested in Horticulture.

ADVERTISEMENTS.

Fellows are reminded that the more they can place their orders with those who advertise in the Society's publications the more likely others are to advertise also, and in this way they may indirectly benefit the Society.

FIG. 123.—LÆLIO-CATTLEYA DIGBYANO-TRIANÆ. (*Journal of Horticulture.*)
(LÆLIA (BRASSAVOLA) DIGBYANA × CATTLEYA TRIANÆ.)

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CONFERENCE REPORT.

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